SUSTAINABLE AND DIGITAL STRATEGIES FOR ENHANCING UNITED ARAB EMIRATES CONSTRUCTION INDUSTRY COMPETITIVENESS

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PhD Thesis **2019**

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A thesis submitted in partial fulfilment of the requirements of the University of Wolverhampton for the degree of Doctor of Philosophy (PhD)

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Signature:

Date: 06.08.2019

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ACKNOWLEDGEMENT

This thesis would never have been accomplished without the help of many people. Thank you for being part of this long journey. My deepest gratitude is for HH Sheikh Saifh Bin Zayed Al Nahyan for his continuous support and for providing me the opportunity to pursue my PhD studies. Would also like to thank for H.E Major General Fares Khalaf AL Mazroui , Commandar-in-Chief of Abu Dhabi Police who rendered his totally support during the period of the study. Also, I would like to thank Abu Dhabi Police GHQ for providing the funds, time and encouragement to accomplish this study.
I proudly like to thank Dr Colonel Badar AL Harithi, Head of Engineering Department at Abu Dhabi Police G.H.Q for providing great opportunity to complete this study.

I would like to express my gratitude to my Director of studies, Dr Suresh Renukappa for the time he invested in meeting with me, for his insightful comments and support that helped this thesis achieved its best shape.

I would like to thank my colleagues Sultan, Faisal, Ayman, and Khaled for being great advisors in adverse and good times. Their clear perspective of things gave me good guidance when I did not know which path to choose. Our discussions helped me to clarify many things and draw a better understanding of my thesis. Their suggestions and ideas were very useful. I would also like to express a special word of thanks to my family and friends for their support and inspiration.

Finally and with a great pleasure, I would like to acknowledge the support, assistances and contribution made by individuals from the beginning of the fieldwork, providing me access, data and information, to the writing process until the completion of this thesis.

DEDICATION

This thesis is dedicated to my father Mr Saeed AL Neyadi, my mother Afra, my wife Aysha, my son Ali, my daughters Shamma and Afra, and my sisters and brothers.

ABSTRACT

The United Arab Emirates (UAE) construction sector is an important industry and contributes approximately 11% of the GDP. It has been the most significant economic activity outside the oil sector. However, recession, uncertainty, complexity, sustainability, and climate change are among the most important features of the current construction business environment in the UAE. Although many construction firms throughout the world have successfully embedded sustainability, there is little information on how UAE construction organisations are embedding sustainability strategies for competitive advantage. Therefore, the aim of this research is to explore how the UAE construction organisations are embedding sustainable strategies to improve their competitive advantage from a social, environmental and economic point of view. The findings are in the main, based on semi-structured interviews with 44 professionals from UAE construction organisations. As part of the analysis of the interviews, content analysis was employed. The unit of analysis adopted for this study is the ‘construction industry’ and the embedded unit is ‘individual employee’.

The study recommend that the overall outlook for improved sustainability initiatives efforts from the UAE construction organisations looks quite promising at present. However, the implementation of green Building Information Modelling (BIM) and mobile applications technologies to tackle sustainability issues are relatively low uptake in the UAE construction organisations. Therefore, there is a need to reshape the UAE construction organisations existing digital strategy in order to gain sustainable competitive advantage. The decision makers have to recognise and understand the concept of sustainability from a triple bottom line concept. It is concluded that before organisations embed sustainability initiatives they need to understand and recognise key drivers, which are pushing them towards implementation. The lack of skills for successful deployment of sustainability strategies is one of the most important challenges for the UAE construction sector. Therefore, there is an urgent need to develop and deliver a bespoke training program to address, improve and measure the effectiveness of leadership skills for driving change towards sustainability. Most of the technologies included in Industry 4.0 are still at their infancies and for the future would recommend more research to be carried out on these technologies, this will enable the construction industry to understand the benefits that can be gained from these technologies and with the industry being known for resisting change, demonstrating these benefits can be the start of the construction industry embracing the change. Furthermore, it is recommended that future research on mobile applications for sustainability should focus on user readiness aspects, as well as organisation readiness for adoption and usage patterns of mobile devices. A framework for managing sustainability strategies in the UAE construction industry was developed and validated. Findings of this research are limited to the UAE construction industry context only, as such, the level of generalisability outside this context may be very limited.

CHAPTER 1 : AN INTRODUCTION TO THE STUDY

This opening chapter discusses the background and justification for embedding sustainability strategies within the United Arab Emirates (UAE) construction industry. It also presents the research aim, objectives, and research questions. Furthermore, it highlights potential benefits of this current research. Finally, it presents the structure of the thesis.

1.1 BACKGROUND TO THE RESEARCH STUDY

Humanity has been continuously incrementing the Earth's pollution over the past centuries. The contamination of the air and water, climate change, soil erosion, biodiversity loss, and the reduction of natural bank account of non-renewable resources are some of the negative impacts that human activities have been generating on the environment during this period. In the long term, humans are damaging the regeneration capacity of the planet and the provision of clean air and water, tolerable climate, fertile soil and the maintenance of biological diversity (Harte, 2007). Overall, there is an increasing tension over the planet's resources that is being intensified by the increasing world population (IPCC, 2007, Ainger and Fenner 2014). Harte (2007) agrees with this and points out that the magnitude of this growth is dynamic and proactive. As a result, the adoption of approaches that permit a sustainable management of the planet's resources has become imperative.

Sustainability is described as the enhancement of the quality of life of human beings without exceeding the supporting capacity of ecosystems, and it is grounded on the reconciliation of environmental, economic and social enquiries. Since its origin, the concept of sustainability refers to development without harming the environment, and it has now been applied to concerns about the future viability of ecosystems in developing countries (Danis et al., 2009).

These issues can be summarised in a set of main problems. According to Sigma Guide to Sustainability Issues (2003), they can be grouped in a list of areas which include accidents, air contamination, biodiversity loss, contaminated land, environmental management, energy consumption, greenhouse gas emissions, climate change, ozone layer depletion, and noise contamination.

In addition, it is said that the world is changing at a great rate. The planet is currently facing the problems that global warming has already started to deliver, and which jeopardise the future generations (IPCC, 2007, Ainger and Fenner 2014). As societies are industrialising and moving out of poverty, negative impacts are rising and increasing the strain on the natural environment and biological diversity (Butchart et al., 2010, Ainger and Fenner 2014).

Global warming is caused by a complex mix of greenhouse gases (GHs) in the atmosphere that is generated by human activities, producing a negative impact on the radiation of the planet. The gas that is most commonly generated by human activities is the carbon dioxide (CO2), which is produced by fossil fuel burning and human land use. In the same way, some other non-CO2 gases are also relevant as they have similar attributes to the effect that CO2 gases produce on the atmosphere. These greenhouse gases include the methane (CH4) and the nitrous oxide (N2O), which can be found naturally in the atmosphere, and some other industrial gases which perfluorocarbons (PFC), hydrofluorocarbons (HFCs), and sulfur hexafluoride (SF6) (Hyman et al., 2003).

In order to face the climate change, all of these gases must be regulated in terms of production as they are generated massively by human daily activities.

According to The World Bank (2016), the CO2 world emissions have increased by 369% from 1960 to 2011. This figure sustains the increasing concerns related to the growing sustainability problems that are currently affecting the environment. In addition, environmental indicators have demonstrated that other non-CO2 gases present a similar behaviour. It can be noted that the annual production of both methane emissions and nitrous emissions have increased by 151% and 142% respectively, which illustrates the level in which the air contamination has been continuously rising during the past decades. These numbers can be appreciated in the Figure below which shows a comparison of emissions between 1970 and 2011 and it also illustrates the distribution of the emissions during 2011.

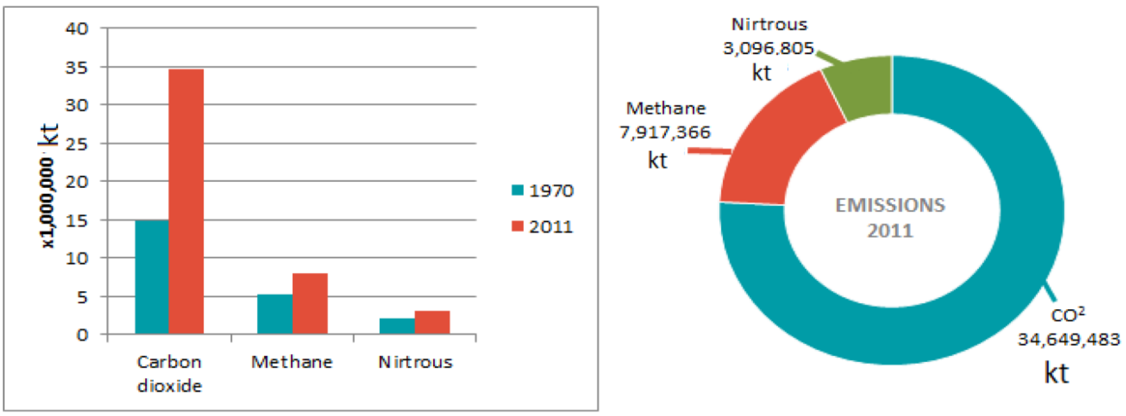


Figure 1.1 and 1.2: Comparison of GHG Emissions between 1970 and 2011
Source: The World Bank Group (2016)

In the same way, this demonstrates that further policies and measures must be adopted in order to produce satisfactory results and to comply with the goal of limiting the world temperature increase derived from greenhouse gases. Randalls (2010) explains that this limitation is set and the target corresponds to 2°C, which is the maximum increase in temperature allowed to be caused by human activities in order to avoid dangerous impacts of the climate. According to Carrington (2016), between 2000 and 2014, thirteen of the fifteen hottest years within the past 150 years of recorded temperature occurred in this period. In Figure 1.3, it can be noticed the growth of the planet's temperature since 1980 and how it is tending to rise.

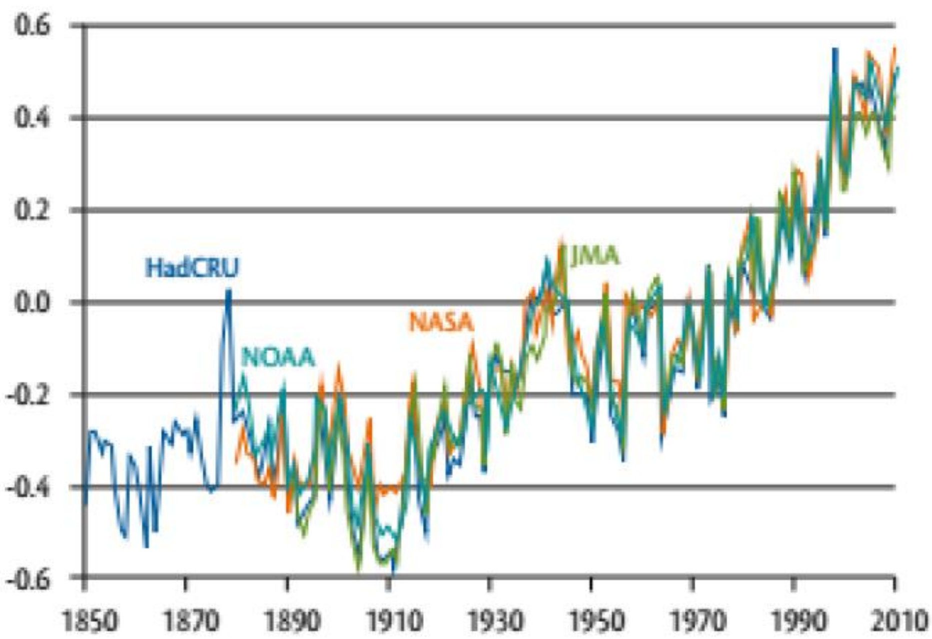


Figure 1.3: Temperature Change of the Planet since 1850
Source: (UNEP, 2012)

In addition, other sustainability issues are also present and increasing their negative effects on the planet. Climate change is also expected to aggravate the water-stressed areas where 2 billion people currently live. On the other hand, 100-200 million hectares are believed to be transformed into urban areas in the next 40 years, leading to more deforestation. Furthermore, 20 percent of the world's mangrove habitat has been lost since 1980, Coral reefs have been reduced by 38 percent since 1980, and wetlands have been shrunk by 50 percent during the 20^{th} century (UNEP, 2012). This illustrates how severely has the planet's biodiversity been impacted in the past decades.

On the other hand, industries are considered primary contributor to this growth in environmental issues. According to the Goldenberg (2013), 67% of the global warming emissions produced by human activities since the industrialisation period were concentrated in 90 companies and the industrial emissions of greenhouse gases since 1751 raises to 1450 gigatonnes. This shows the necessity of implementing new operation conditions and innovative process in companies, in order to alleviate the effects that these are causing to the environment.

In addition, during 2008 the disruptions caused by extreme weather affected twenty-nine per cent of businesses in the United Kingdom, and this figure is expected to increment as a result of the climate change (UKCIP, 2010). As a consequence, businesses are already being affected by the problems that are currently impacting the environment, which should call to the embracement of new strategies that can strengthen their commitment to comply with their environmental responsibility.

In the same way, around 6.5 billion cubic metres of water, abstracted in the United Kingdom between 2006 and 2007, was directly used by businesses in England and Wales. This is tremendously relevant as it is expected that warmer summers and more humid winters will be present in the near future, increasing the strain on the water supply (DEFRA, 2013). As a result, the implementation of sustainable ways of managing water is highly relevant in order to secure the water supply potentially needed.

Additionally, during 2008, the manufacturing sector of the UK accounted for 23 percent of carbon dioxide emissions. In terms of waste, during 2009, England generated 47.9 million tonnes of commercial and industrial (C&I) waste. In this period, businesses accounted for 25 percent of all the waste produced in England. Nevertheless, it is imperative that organisations reduce their waste generation as it affects the economy and business efficiency. The productivity can be highly improved by utilising less material in the creation process of products, and therefore, reducing costs of waste treatment and disposal while developing new opportunities and jobs (DEFRA, 2013). The distribution of waste during 2009 is illustrated in Figure 4.

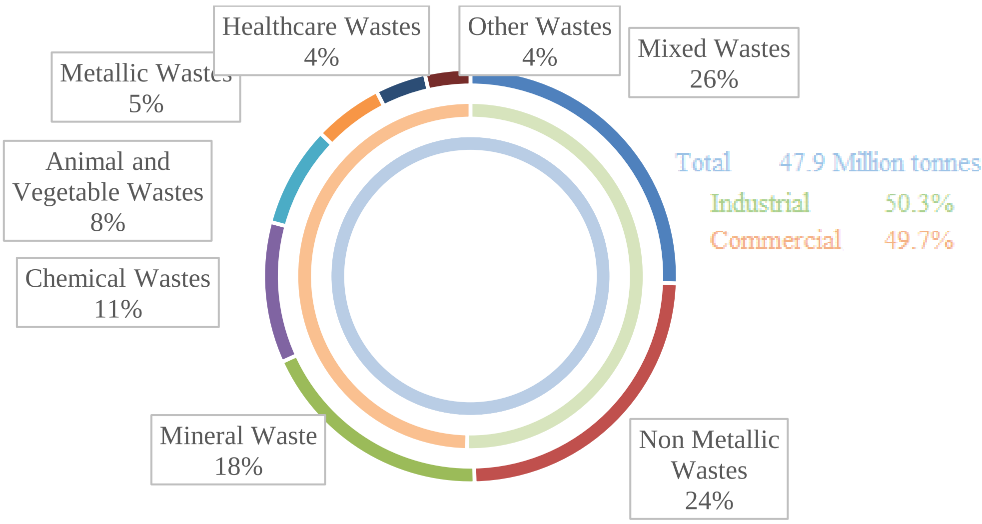


Figure 1.4: Waste Distribution in the United Kingdom during 2009

Source: DEFRA (2013)

The increasing concerns related to the global climate change and the instability of the energy markets has initiated some notions in green information and communication technologies (Martinez, et al., 2018; Bronk et al., 2010). On the other hand, transportation is the largest generator of carbon dioxide emissions in the average American household, and as it is a movable activity, mobile applications are highly effective in the control of this action by producing feedback that can help users understand their transportation behaviour (Froehlich et al., 2009).

It is explained that by implementing mobile applications the emission of carbon dioxide generated by transportation activities can be significantly reduced (Froehlich et al., 2009). In addition, the advent of innovative mobile technologies has modified the way in which companies work around the world. The mobile revolution, which is headed by the applications developers, also provides solutions in websites, voice, SMS, and native applications. The availability of global markets has highly facilitated the development and distribution of thousands of app around the world, with more than 450,000 application on Google Play, and 500,000 on the App Sore (Danis et al., 2009).

Extensive reports show how a new sustainable business model is replacing the business model of the 19th century in the 21st century (Martinez, et al., 2018; Renukappa et al. 2013). The practice of this new business model is mainly due to the high competition that exists within a specific industry. Competition stands as one of the deciding factors that driven an industry to succeed or to fail (Porter, 2004). Throughout the 21st century, competition in business does not limit itself to a competition between mere products, but has rather taken a turn to competition between business models (Talonen and Hakkarainen, 2014).

One of the main expected outcomes of implementing sustainability strategies in a firm is to have a competitive advantage over others. The concept of competitive advantage is not to be understood as the gains from favorable trade sales in which revenues exceed production or economic costs; the concept rather aims to define a position in which a firm establishes a profitable and sustainable position against the factors that may determine competition within its industry, while at the same time adapting for future possible changes in market (Porter, 2004). The main point of pursuing competitive advantage is the ability to achieve a long-term profitability within a specific industry.

Throughout the 21st century, the new business models tend to aim for sustainable growth. Embedding sustainable strategies in order to acquire a competitive advantage over other firms has thrown out more questions than answers and many experts often tend to question it (Clem, 2012). The main issues tackling these strategies is the cost and price implications that applying these strategies translate into, and the fact that in order to pursue sustainability, a long-term commitment must exist within a firm; the leadership's vision, support and commitment is of extreme importance in order to put this strategies into place (Schroeder and Robinson, 2010).

In the construction industry, the survival of a firm depends on its ability to secure contracts and earn a profit while meeting its client's requirements. Based on this, the growth of a company may translate directly into the number of contracts awarded to it. Ngowi and Rwelamila (1999) point out that although the ability of a firm to win a contract may depend on luck as well as on a planned approach, the ability of that same firm to execute that contract successfully depends entirely on the management decisions and methods used. Taking this into consideration the importance of competitive advantage in the construction industry can be seen. It is stated by Picard (1998) that construction projects in the 21st century are more complex, dynamic and uncertain and in order to face the possible problems this projects present, new management techniques that focus on aspects other than cost time and quality need to taken into consideration.

The importance of sustainability in competitive advantage is the fact that the advantage over other firms can be sustained over time (Liu, 2013). Firms that can sustain their competitive advantage are able to outperform others over time. A sustainable competitive advantage system brings constant awareness and knowledge of efficiency to the project while at the same time reduces the expected problems by providing the best plan possible (Picard, 1998). In order to maintain and sustain a competitive advantage over time, a firm must be able to constantly improve and adapt to changes. Ngowi and

Rwelamila (1999) explain how competitive advantage in the construction industry can be seen as having a good management system, a unique technology and a financial capacity greater than other firms; the main problem is that this advantages are easily imitated by other firms and the importance of sustainability is pointed out because of the fact that it helps to quickly react to changes in the environment.

Wells (1983) explains how third world countries constantly aim to shift from being only producers of raw material to manufacturing countries; this translates into a social and economic growth. The main problem with this growth is that third world countries often ignore the environmental issues that are created by this growth. Therefore the competitive advantage is merely economical and can be considered unsustainable. It is stated by Grant (1991) that this unsustainable markets lack of competitive advantage; they merely reflect a price based on the information available and they adjust as new information comes by. These types of market are considered to lack of competitive advantage because they can be easily be imitated. Resources such as money and information cannot be considered an advantage because they are available to everyone, therefore they cannot be sustained.

For the purpose of this research, sustainable competitive advantage is defined as: "A long-term competitive advantage that is not easily duplicable or improved by the competitor". Renukappa *et al*. (2013) explain the importance of pursuing sustainable initiatives as four key reasons:

- It helps firm leaders to identify the key sustainable drivers within their industry.
- It helps firm leaders identify possible sustainability threats and opportunities within their industry.

- It helps decision makers to develop future sustainable business strategies that address the drivers in their industry.
- It exposes the benefits of a sustainable organisation, allowing firms to shift to these initiatives by evaluating the performance of their actions.

1.2 JUSTIFICATION FOR THE STUDY

Increasingly In order to understand the concept of sustainable construction is imperative to understand the term “sustainable”. Sustainable development is “the development that fulfils the needs of the present generation without compromising the ability of the future generation to meet their own needs, regardless of setting aims because the continuation of the development is the most important aim” (El-Alfy, 2010).

Regarding “Sustainable Construction” (SC), the first definition is from the first International Conference on Sustainable Construction celebrated in Tampa in 1994, where Charles Kibert (1994) defined it as follow: ‘sustainable construction is the creation and responsible management of a healthy build environment based on resource and ecological principles’. That definition of SC received an upgrade in the Agenda 21 (A21) for Sustainable Construction in Developing Countries when they defined it as “a holistic process aiming to restore and maintain harmony between the natural and the built environments, and create settlements that affirm human dignity and encourage economic equity” (Du Plessis, 2002).

Sustainability has become a major policy issue and, as explained by Chereja (2013), and while this occurs the construction industry has not been able to catch up on sustainable practices in order to comply with these new policies. Even though construction companies are aware of the concept “sustainable construction” (SC) they have not been able to prepare a practical approach to lay down their strategic agenda in order to simultaneously address issues related to finance, human development, environmental quality and social equity. Moreover Mateus and Braganca (2011) suggests that building projects can be viewed as sustainable only when all the different dimensions (environmental, economic, social and cultural) are taken into account. They add that the climate consequences of the modern development and growing international movement towards high-performance/sustainable buildings are changing the way we see construction rapidly and that such changes are affecting the nature of the built environment and the actual method of designing and constructing a facility.

Bon and Hutchinson (2000) argues that SC faces many challenges at a macro, meso and micro level of economic analysis that need to be addressed in order to implement a sustainable agenda in a specific project or an a general level. That is partially supported by (Ofori, 2000), who states that there is a belief that countries only pay attention to the environment when they reach a high level of socio-economic development, when in reality it should be even of greater importance for developing countries.

These rapid changes must be assimilated by all countries in order to collaborate with the mitigation of the climate change impact. In the specific case of the UAE, with a very traditional construction industry, the challenges confronted by developed countries in the matter seems to be insuperable for his construction industry, which can be defined as traditional and fragile. This research looks to identify the principal challenges and the overall perception on the matter of Sustainable Construction among construction professionals in the UAE.

The defining characteristic of the successful 21st Century construction organisation will be its ability to embed sustainability in every fiber of its operations. Therefore, the UAE Government is encouraging the implementation of sustainability programmes. However, the extent to which the UAE construction sector embrace sustainability issues as an integral pillar of their business models remains unclear and poorly investigated.

Building Information Modelling (BIM) and Sustainability

In recent years, there has been an increasing demand from builders about sustainability management applications to accomplish eco-friendly engineering. Warnock (2007) considers that to assist the shift towards sustainable construction, is necessary to have a joint between all the factors influencing the project. This view is supported by Hwang and Low (2012), who noted that the industries have opted for the application of environmental measures to minimise the negative effects produced by humanity to the environment, involving the project managers and a set of decisions that promote sustainable business development. Fundaments of sustainable construction apply to the entire project life cycle, from initial planning to final disposition (Kibert, 2013).

Construction aims to achieve a final product that meets customer needs at the right time and inside budget. Despite this, buildings are being built with ineffective resources, polluting materials, inefficient equipment and poor communication with communities. This conventional construction process for its planning, design and elaboration often does not allow the development of skills and knowledge builders for effective buildings. Due of shortcomings affecting the construction sector major changes are required in culture, attitudes and working practices, in order to get a balance between quality and price (Elmualim and Gilder, 2013). It is necessary for project managers to develop strategies to reduce or control costs during the initial phase, because the benefits of operational savings are not relevant to investors who are not interested in the other project phases (Robichaud and Anantatmula, 2011). The growing preoccupation with the problems of climate change and on fossil fuels energetic dependence, and also the need for profitable buildings has resulted in the adoption of green building strategies (McGraw-Hill Construction, 2010).

About fifteen years have passed since the first time the concept of green building was used (Kibert, 2013). Green building is a trend driven by a small group of dedicated professionals, which has achieved importance in the construction industry (McGraw-Hill Construction, 2010). Builders are changing their way of thinking, regarding the use given to water, energy and resources utilised to construct, permitting the development of this methodology (Hardin, 2009). The green building market owes its growth mainly to higher energy costs, the price of building materials, and regulatory mainspring. Despite this, the execution of a green project within an acceptable cost is still an obstacle (Robichaud and Anantatmula, 2011).

The term BIM is generally understood to mean as a methodology that enables to produce and manage data in a construction during its life cycle, which is translated into a reduction of time and costs price (Silverio-Fernandez, et. Al., 2019; Elmualim and Gilder, 2013). Another clear definition is given by Gisbert et al., (2014) who defines BIM as a digital representation of physical and functional characteristics of a building, using open standards, intended to facilitate decision making not only in the design and construction but throughout its life cycle. BIM has as a main objective, to enable an overview of the building or project and virtually construct a building before initiating construction on site (Krygiel and Nies, 2008). BIM can meet the environmental demands of users, focusing on integrated design (Bryde et al., 2012). Set in the early stages of the project and increase the safety of people and the environment, safely store green building materials, use green building practices, and increase efficiency by using technologies, are some of the many skills offered by BIM (Hardin, 2009).

BIM is a sustainable method to achieve sustainable results (Bryde et al., 2012). Building Information Modelling plays an important role at the time to attain energy efficiency or fulfil the aim of constructing civil projects of low carbon emissions, all this is possible because the supply chain of construction can be homogenised. Design managers can also get feedback on their designs, such as what will be the project energy consumption, CO2 emissions assumed, and knowing in advance whether the project will comply with the performance criteria (Ex. LEED or BREAM). In the design phase, BIM has applications that deliver improvements in this process. Despite all the advantages that BIM can offer, there is still no adequate methodology which allows monitoring after the occupation that energy criteria were applied in the design and were achieved in practice (Motawa and Carter, 2013).

BIM, despite having a strong impact on the forms of design and construction, is a bit modest on its adoption by companies, even so has shown a significant growth. The utilisation of green building and BIM tools has emerged over the last decade, positioning as two trends capable of changing the approach used to design and construct. Both trends have moved separately, but many professionals seek to demonstrate that there are great similarities between them. To achieve a good Green Design, an integrated design is needed, which is achieved with ease using BIM. Another advantage is that BIM enables greater use of prefabrication, thus helping a greener and faster construction. In spite of all the advantages to be gained from the use of BIM in Green Projects, 53% of builders say that they not have the necessity to implement the methodology due a variety of factors, including low demand and lack of direct customers (McGraw-Hill Construction, 2010).

The Construction Industry

Most human activities that impact on the environment have backwards or forward linkages to the construction industry and their impact can be mitigated through changes in the practices of the construction industry. Therefore as Du Plessis (2002) explains the construction industry is central to how we shape our future, and to the sustainability of this future. The industry impacts on almost every aspect of the realisation of human settlements and the creation of infrastructure that supports development.

The construction industry is the largest industrial employer in the world with 111 million employees worldwide, according to data presented in Du Plessis (2002). Of these total, 74% are in the developing countries with a low income. Hence these countries produce only 23% of the global construction output, it is clear that the "employment intensity" of construction activities is much higher for developing countries in comparison with developed countries.

Nevertheless Gomes and Gomes da Silva (2005) points out that more construction is needed to provide prosperity, social equalisation and minimum standards of living. The continuing urban population growth and rapid urbanisation puts an increasing pressure on the by now insufficient and limited infrastructure of urbanised areas.

In the Gulf countries, governments are taking significant steps to reconfigure their business models and measures are being adopted to move away from oil-based economies, create economic sustainability and continue infrastructure investment, a key element of the business environment and a generator of employment (Deloitte, 2016). However, the low oil prices will constrain the amount of funding available to regional governments that will have to innovate and find alternative funding sources to bridge the funding gap.

The GCC Member States share a strong interest in increasing building performance to achieve environmental benefits, with energy efficiency and water conservation being key focal areas for the hot, arid climate zone. Therefore, the UAE Government has taken measures to promote a more sustainably built environment, there also are indications of interest in aligning certain initiatives across the region to facilitate commerce and ensure that the world's leading technologies can be used in regional construction projects.

The United Arab Emirates (UAE) construction sector is an important industry and contributes approximately 11% of the GDP. It has been the most significant economic activity outside the oil sector. However, recession, uncertainty, complexity, sustainability, and climate change are among the most important features of the current construction business environment in the UAE. Although many construction firms throughout the world have successfully embedded sustainability, there is little information on how UAE construction organisations are embedding sustainability strategies for competitive advantage.

1.3 RESEARCH AIM AND OBJECTIVES

The aim of this research is to explore how organisations in the United Arab Emirates (UAE) construction industry are embedding sustainable and digital strategies to improve their competitive advantage from a social, environmental and economic point of view. The specific objectives are:

- To investigate and document the perception of UAE construction sector on the concept of sustainability
- To explore and document the key drivers for implementing sustainability strategies in the UAE construction organisations
- To investigate and document the key sustainability strategies needed to effect change that are currently being implemented in the UAE construction organisations
- To critically appraise and document the main challenges the UAE construction organisations face in implementing sustainability strategies.
- To critically analyse the implementation of green Building Information Modelling (BIM) strategies in achieving the sustainability goals of the UAE construction organisations
- To critically analyse the implementation of mobile application technologies to address sustainability issues in the UAE construction industry
- To develop and validate a framework for managing sustainability strategies in the UAE construction industry

1.4 RESEARCH QUESTIONS

A set of research questions were developed through a review of the existing literature to guide the research. Hence, the research study sought to collect descriptive data to answer and examine the following research questions: (see Table 1.1)

1. What does sustainability mean to UAE construction organisations?
2. What are the key drivers that have fuelled the need for implementing sustainability strategies in the UAE construction organisations?

3. What are the key sustainability strategies currently being implemented in the UAE construction organisations needed to effect change?
4. What key challenges do UAE construction organisations face in implementing sustainability strategies?
5. What are the key green BIM strategies currently being implemented in in achieving the sustainability goals of the UAE construction organisations?
6. How can the implementation of mobile application technologies support UAE construction organisations in the mitigation and control of their current sustainability problems?
7. Is there a need for developing a framework for managing sustainability strategies in the UAE construction industry?

Table 1.1: Traceability matrix of research objectives, research questions and chapter addressed

Sl. No.	Research Objectives		Research Questions	Chapter addressed
RO1	To investigate and document the perception of UAE construction sector on the concept of sustainability	**RQ1**	What does sustainability mean to UAE construction organisations?	**Chapter 2** **Chapter 3** **Chapter 5**
RO2	To explore and document the key drivers for implementing sustainability strategies in the UAE construction organisations	**RQ2**	What are the key drivers that have fuelled the need for implementing sustainability strategies in the UAE construction organisations?	**Chapter 2** **Chapter 3** **Chapter 5**
RO3	To investigate and document the key sustainability strategies needed to effect change that are currently being implemented in the UAE construction organisations	**RQ3**	What are the key sustainability strategies currently being implemented in the UAE construction organisations needed to effect change?	**Chapter 2** **Chapter 3** **Chapter 6**
RO4	To critically appraise and document the main challenges the UAE construction organisations face in implementing sustainability strategies.	**RQ4**	What key challenges do UAE construction organisations face in implementing sustainability strategies?	**Chapter 2** **Chapter 3** **Chapter 7**
RO5	To critically analyse the implementation of green Building Information Modelling (BIM) strategies in achieving the sustainability goals of the UAE construction organisations	**RQ5**	What are the key green BIM strategies currently being implemented in in achieving the sustainability goals of the UAE construction organisations?	**Chapter 2** **Chapter 3** **Chapter 8**
RO6	To critically analyse the implementation of mobile application technologies to address sustainability issues in the UAE construction industry	**RQ6**	How can the implementation of mobile application technologies support UAE construction organisations in the mitigation and control of their current sustainability problems?	**Chapter 2** **Chapter 3** **Chapter 9**
RO7	To develop and validate a framework for managing sustainability strategies in the UAE construction industry	**RQ7**	Is there a need for developing a framework for managing sustainability strategies in the UAE construction industry?	**Chapter 2** **Chapter 3** **Chapter 10**

Legend: RO = Research Objective; **RQ** = Research Question

1.5 CONTRIBUTION TO KNOWLEDGE

This thesis makes a contribution to empirical knowledge of implementing sustainable and digital strategies for competitive advantage in the UAE construction industry. Phillips and Pugh (2010) identify a number of ways in which a PhD thesis may be considered to be original. The first of these is: “setting down a major piece of new information in writing for the first time”. This thesis explores and analyses the implementation of sustainable strategies for competitive advantage in the UAE construction organisations. The context is therefore of particular interest and the study of it capable of making a useful contribution to empirical knowledge. The study will be of benefit to employees, managers, and leaders at every level and in every function of the UAE construction organisations. The results of the study will:

- Improve understanding and awareness of the meaning of sustainability, green BIM and mobile applications at a conceptual level.
- Increase understanding on the key drivers for implementing sustainability strategies. This could assist decision makers to develop and deploy sustainability strategy based on key drivers.
- Assist decision makers to identify and implement key sustainability strategies.
- Improve awareness of the key challenges the UAE construction organisations face in implementing sustainability strategies.
- The developed framework provides broader guidance for organisations to manage sustainable and digital strategies into day-to-day practices. The framework could also help decision makers to craft and deploy key sustainability strategies to improve competitiveness.

The outcomes of the current study have already been published in one referred journal paper and nine conference papers to academics and practitioners. This research has therefore contributed both to the industry as well as the academic community.

1.6 SCOPE AND LIMITATIONS OF THE STUDY

The empirical scope of this study is limited to the UAE construction organisations. The unit of analysis adopted for this study is the ‘construction industry’ and the embedded unit is ‘individual employee’. Therefore, this study does not report the differences between micro enterprises, small and medium-sized enterprises’ and large organisations approach to sustainability strategies for improved competitiveness.

The research reported in this study is largely exploratory in nature. This is because of the inductive nature of the methodology adopted. The goal of this research is to answer the research questions rather than testing hypothesis. Additional research with more elaborate and articulated designs is therefore called for, to further explore the complex relationships with implementing sustainability strategies for improved construction organisations competitiveness.

A framework for managing sustainable and digital strategies in the UAE construction industry is developed and validated. Even though the framework which has been developed and validated with experienced professionals, it has not been tested within an organisation.

1.7 STRUCTURE OF THE THESIS

The layout of the thesis is in a logical sequence, commencing with the introduction to the investigation in chapter 1 to the conclusions and recommendations in chapter 11.

Chapter 1 – explains the background and justification for the study. Then it discusses the research aim, objectives and research questions. Also it highlights the contribution to knowledge, scope and limitations of the study and gives a brief overview of the other chapters.

Chapter 2 – Following the introduction, the second chapter reviews the relevant literature on the sustainability and sustainable construction.

Chapter 3 – This chapter focuses primarily on the topics Building Information Modelling, green and sustainable construction, and application of BIM in sustainable construction. Also, it presents the results of previous studies about triggers, drivers and barriers for the current and future use of BIM on Green projects. Furthermore, this chapter explores the concept of mobile application technologies.

Chapter 4 – discusses the research methodology that is used to empirically investigate the research aim and objectives. The chapter also discusses why a qualitative methodology was adopted. Furthermore, the sample size chosen for the study has been explained. Research process adopted for the study has also been described.

Chapter 5 – discusses the perceptions of the UAE construction organisations on the concept of sustainability and key drivers that have fuelled the need for implementing sustainability initiatives in the UAE construction organisations. The discussion is based on qualitative data. Overall, chapter 5 addresses objectives 1 and 2. Finally, chapter 5 concludes with a summary.

Chapter 6 – present the key sustainability strategies that have been implemented in the UAE construction organisations. The results discussed in this chapter are based on qualitative data. Overall, chapter 6 addresses objective 3. Finally, chapter 6 concludes with a summary.

Chapter 7 – present on the key challenges the UAE construction organisations face in implementing sustainability strategies. The results discussed in this chapter are based on qualitative data. Overall, chapter 7 addresses objectives 4 of this study. Finally, chapter 7 concludes with a summary.

Chapter 8 – present on the implementation of green Building Information Modelling (BIM) strategies in achieving the sustainability goals of the UAE construction organisations. The results discussed in this chapter are based on qualitative data. Overall, chapter 8 addresses objectives 5 of this study. Finally, chapter 8 concludes with a summary.

Chapter 9 – present on the implementation of mobile application technologies to address sustainability issues in the UAE construction industry based on qualitative data. Overall, chapter 9 addresses objectives 6 of this study. Finally, chapter 9 concludes with a summary.

Chapter 10 – discusses a framework for managing sustainability strategies in the UAE construction industry. The findings from the previous stages of this research study were taken into consideration in the development of the framework. Finally, chapter 10 concludes with a summary. Overall, chapter 10 addresses the objective 7 of the current study.

Chapter 11 – focuses on the conclusions and recommendations drawn from this study. It summarises the key findings of this research and also provides recommendations for the future research in the area of embedding sustainability strategies in the UAE construction organisations.

CHAPTER 2 : EMBEDDING SUSTAINABLE STRATEGIES AS A COMPETITIVE ADVANTAGE: DRIVERS, CHALLENGES AND BENEFITS

2.1 INTRODUCTION

In this chapter, a review of the existing literature in relation to the drivers, challenges and benefits of embedding sustainable strategies as a competitive advantage is explored. The main point is to understand the positive impact of embedding sustainable strategies and how they can positively affect an industry from a social, economic and environmental point of view. The goal of this literature review is to acquire relevant information to this area of study and to understand what approach has been taken to the day by different sectors in order to identify the importance of embedding sustainable strategies and the methods used to pursue them. The objective of this chapter is to conduct an investigation into the already existing information through all available resources, which include: journal papers, conference papers, textbooks, and articles, among others.

2.2 SUSTAINABILITY

A dramatic change is currently being affecting humanity, as an increasing amount of individuals are moving to urban areas. During the last two centuries, the number of people living in urban areas has increased five times to up to 50%, and it is said that it will increase even more during the upcoming 50 years as people in cities will be accountable for more than 95% of the increase in global population. Even though the increase in urban population has only occurred on less than 3% of the world surface, it has highly impacted the overall planet with an increase of 78% of carbon emissions, 76% of wood used in industries, and 60% of residential water use (Grimm et al., 2008).

The stability and well-functioning of the life support systems, which are the biosphere's ecological and physical structures, defines the health of the population. Nevertheless, this is easily ignored by humans as the world is becoming more urbanized and segregated from nature. In addition, human's daily activities are constantly introducing new contaminants to the environment that can alter the cycle of these systems, which is the case of the Earth's natural greenhouse effect that is presently being amplified by the vast amount of greenhouse gases being emitted (McMichael, 2003).

Global environmental change is becoming more evident with the manifestations of events such as global water crisis, global warming, and the loss of biodiversity. The society and economists are becoming more aware of the necessity of addressing the current sustainability issues by considering the way that human beings interact with nature and how responsible the human beings are with one another and future generations (Baumgärtner and Quaas, 2009).

Sustainability was first introduced in 1713 as the German word for sustainability, Nachhaltigkei. This concept was incorporated in forestry and it denoted the balance of what is harvested with what growths. Later, this term was used by English and French foresters who adopted this practice (Heinberg, 2010). However, the term goes beyond this date as human beings have always being concerned with preserving natural resources for the future. Since the beginning of civilisations, there have possibly been two options regarding the relation between nature and the human race which are opposing to each other. One sees the benefit of living in harmony with the environment while the other seeks to conquer nature. The latter has been more present in the western cities in the past centuries (Kuhlman and Farrington, 2010).

On the other hand, it can be assumed that no human arrangement will last forever. This is proved by the fact that in several billions of years the sun will heat the earth to the point of provoking the evaporation of the oceans, and hence making the earth inhabitable. As a result, the concept sustainability is relative and must be analysed in terms of a unit of duration. If previous civilisations are considered, it is reasonable to refer to this term from hundreds to thousands of years. Thus, a sustainable society would maintain itself for at least several centuries (Kuhlman and Farrington, 2010). It is essential to acknowledge that this term denotes the justice within the human domain, which means that our relationship with nature and its uncertain future is contemplated. Accordingly, it must also be recognized that the human being has other aspects of justice to maintain such as labour and education. These other areas must be analysed in harmony with sustainability in order to find a consistent solution (Baumgärtner and Quaas, 2009).

Besides the focus on justice that sustainability has, economics concentrate on an ever better satisfaction of human beings' necessities and desires. From a broad perspective, this includes the individual subjective preferences and wishes and how this can be maintained for future generations, the latter being tackled by sustainability economics (Baumgärtner and Quaas, 2009).

The increase in production has become the dominating issue in human relations with economic growth, which was seen as the way to achieve human's wellbeing. With the support of development, those at the bottom can be raised out of poverty as economic growth helped everyone to float higher. With this, sustainable development has raised as a strong link between environmental concerns and socio-economic problems, which seeks to attack poverty, inequality and the attainment of a healthy future generation (Hopwood et al., 2005).

On the other hand, transformationists include a focus on those who aim either the environment or the socio-economic, as well as those who combine both. Transformationists express that the mere people's behaviour in the present society and the interconnection with the environment is aiming an increase of the environmental problems, and suggest that a transformation of the main features of society and human relation with the environment is required in order to mitigate these problems and to evade a future crisis. In addition, a reform would not solve the whole problem as this is concentrated within the very economic and power configuration of society as they are not concerned with human welfare or environment sustainability (Hopwood et al., 2005).

2.3 AWARENESS AFTER BRUNTLAND REPORT

It is imperative to connect the natural and socio-economic system in order to think about sustainability development and sustainability. Thus, it is correspondingly relevant to address the principle of interdisciplinary, which calls for the integration of theories, concepts, techniques, and data from different bodies of knowledge. In addition, the Brundtland Report requested the balancing of economic growth with ecological integrity, and since then, the relation between issues such as poverty and climate change has become more evident (Schoolman et al., 2012).

Socio-economic is considered twice as important as sustainability, as the former emphasises on the welfare of the present generation and the latter focuses on being concerned about the future, which infringes the Brundtland requirement that future generations cannot be negatively affected by the development of the present generation (Schoolman et al., 2012).

The human dependency on the environment was raised in the report Our Common Future or the Brundtland Report as it is commonly known. The interconnection between ecology and economy is becoming stronger and goes beyond the mere exploitation of resources in local, regional, national and global perspective (WCED, 1987, In Hopwood et al. 2005). Giddings et al. (2002, In Hopwood et al. 2005) add that beyond the supremacy over nature, our activities and society is merged with the environment. The report expresses that the human being needs the environment for security, basic existence, economy and the future generations, regardless of being an industrialized or rural society (Hopwood et al., 2005).

Vallance et al. (2011) presented a remarkable change in the way humans were attempting to link the policy goals for social, economic and environmental issues. Since the publication of the Brundtland report, a set of new concepts related to sustainability have emerged. Some of these new focuses of study are sustainable development, sustainable management, urban sustainability, strong and weak sustainability, and environmental sustainability.

The Brundltland Report provides a definition for sustainable development which describes it as the "*Development that meets the needs of the present without compromising the ability of future generations to meet their own needs*" (WCED, 1987). This definition is normally used to refer to social sustainability as it provides the opportunity to reconcile people's needs with environmental management while obtaining economic development. In order to achieve this, a huge effort is required that permits to overcome life necessities, which is said to depend on reorienting the quality of growth, providing a sustainable level of population, maintaining the resource base, and providing the solution to the need of food, job, water, energy and sanitation (Vallance et al., 2011).

One concern that is affecting the sustainable development and that is addressed in the social sustainability of housing literature, is that people can only initiate to actively attack environmental concerns once their basic needs are met (Vallance et al., 2011). This is supported by Crabtree (2005, In Vallance et al 2011), who illustrated that poverty can function as a barrier to the integration of green alternatives in areas such as the generation of electricity and on-site waste disposal.

2.4 TRIPLE BOTTOM LINE: SOCIAL, ENVIRONMENTAL, AND FINANCIAL

On the Brundtland Report, it was realised that two main concepts had to be merged: environment and development, which are also seen as short versus long term or needs versus resources. However, sustainability is best illustrated with the use of three terms which are social, economic and environmental (Kuhlman and Farrington, 2010). The Triple Bottom Line (TBL) is a framework that involves these three parameters and differentiates from conventional reporting frameworks in the inclusion of social and environmental measures whose means of measurement can be arduous to allocate. The TBL dimensions can also be frequently referred to as the 3Ps: planet, people, and profit (Slaper and Hall, 2011).

Although the government has to use the revenue in order to cover the expenditure just as it is done in businesses, it is considered that this differs from businesses as it is not supposed to produce a profit. As a result, in order to understand the money produced by a country, the Gross Domestic Product (GDP) is explored. This term is used to measure the welfare of a country, although it is biased and might need to be accompanied by other indices such as the Human Development Index (HDI) in order to produce a good estimation of the economic activity of a country.

In addition, it is said that if the analysis is revised with only two dimensions (socio-economic and environment), then the environmental benefits comes at the expense of welfare. But if a three dimension analysis is used, then the environmental parameter receives less weight. This is supported by some authors who point out that the three dimensions must receive the same weight. With this, sustainability is translated as good, and therefore can be implemented as a mechanism to assure the stakeholders' good intentions (Kuhlman and Farrington, 2010).

Alternatives have been revised in order to tackle sustainable issues. Dobson (2007) illustrates the efficiency of introducing fiscal's route in order to alter peoples' behaviour. This is shown by presenting the results of a road-pricing policy that was adopted by the city of Durham. It is known that this city has an old city centre that had begun to suffer from the constant flow of traffic. In response to this issue, city planners adopted a road-pricing scheme that regulated the traffic, cutting it down by 90% in a few months and succeeding the expectations. The presented example can be adapted to provide solutions to the sustainable issues by creating a policy that both incentive the use of green technologies and discourage the utilization of harming technologies. Alternatively, another area of study that has emerged due to the need of facing the sustainability problems by businesses is the Corporate Social Responsibility (CSR).

2.5 CORPORATE SOCIAL RESPONSIBILITY

The Corporate Social Responsibility (CSR) is a result of the post-World War II period. CSR has notably grown since then, with the change in social consciousness that resulted from the social movements of the 1960s such as women's, customers' and environmental movements and with the enforcement of the human rights. Nowadays, with the ascending support of stakeholders who express that business should represent more than the production of money and obedience of the law, CSR has become a global concept which represents a perception and set of codes that is known around the world (Carroll, 2015). In the same way, CSR has become an internal part of companies. It directs the way in which the company's activities are going to be undertaken while considering the increasing environment contamination and the shortage of goods, and by respecting the society (Nalband and Al-Amri, 2013).

According to Carroll (1979, In Nalband and Al-Amri, 2013), the expectations that society has upon the legal, economic and discretionary aspects are what shape the social responsibility of businesses. In other terms, this concept expresses the set of activities that the company will be adopting in order to benefit the society. It helps change the destiny of future generations by providing training and education to humanity and by considering the problems that can be adopted to provide a better future (Nalband and Al-Amri, 2013).

2.6 CONTEMPORARY SUSTAINABILITY PROBLEMS

The socio-economic factors that produce the sustainability problems are becoming more globalized in terms of their presence and the negative effects that it triggers. Throughout history, the human being has faced dreadful environmental conditions, although the current sustainability issues have emerged with the industrialisation and massive urbanization. As an example, problems of air and water pollution in the United States that were produced by factories and urbanization were considered as substantial problems during the 1960s. This concern shortly moved to other areas such as soil erosion, loss of biodiversity, deforestation, and pesticide pollution (Dunlap and Jorgenson, 2012).

Additionally, the incompatibility of major problems at a geographical scale has become more apparent. Human activities have led to deforestation, climate change, loss of biodiversity, and ozone layer depletion with the contemporary search for living space, land for cultivation and the need for timber. On the other hand, the world is being threatened by the global warming which has the potential to make some areas inhabitable or less productive for cultivation, along with the possible harm to coral feeds and some fish species that will not be able to adapt to the resulting increase in temperature. The nature of these problems, which are evidently spread over the world, represents a globalization of sustainability problems (Dunlap and Jorgenson, 2012). And therefore, they must be revised and analysed in an international context.

2.6.1 Climate Change

For the first time, it has been indicated that humans are able to influence the climate of the world by triggering an induced climate change that can generate severe complications to the quality of life of hundreds of millions of people. This illustrates the human's inventiveness and predominance over the planet, but it also delivers a warning of its possible serious costs (Nordås and Gleditsch, 2007).

Due to the global implications of the climate change, concerns about security issues have been raised (Nordåsa and Gleditscha, 2007). It is said that with climate change, the population that depends on employment that makes direct use of the natural resources will be substantially affected. This is due to the collateral effects that would incite a reduction in rainfalls and would complicate the accessibility of natural resources that withstand life. This would result in an intensification of poverty and would motivate rebel movements (Barnett and Adger, 2007).

It is said that climate change will produce the movement of species toward the poles. This could result in the extinction of some of these species that do not possess dispersal abilities or cannot find an appropriate habitat. On the other hand, fishes will be affected in abundance and location which will severely impact the commercial fisheries (Perry et al., 2005).

Today, there are two major experiments that are being carried out regarding climate change. One of these investigations is sociocultural experiment around the world that seeks to reduce the emission of greenhouse gases to a range that can be managed. In the same way, the second test belongs to one that has not been carried out before by the human race, this experiment is pointed out by the American geophysicist Roger Revelle, who said that human beings are attempting a major geophysical experiment that could not have been persecuted before and that cannot be replicated in the future (Hulme and Mahony, 2010).

In the last decades, the negative effects of climate change have become more noticeable and more frequent, which has caused the responses to the climate mitigation to be stricter. The goal that is commonly agreed for 2100 by governments, in regards to the elevation in temperature generated by greenhouse gases, is 2 Celsius degrees higher than pre-industrial times However, every year the remaining time decreases while the mitigation cost for the climate change tends to grow, as the accomplishment of the goal is being delayed (Rosen and Guenther, 2014).

2.6.2 Water Pollution

Rivers are a fundamental element of human activities, it is normally utilised as a drinking water font, sewage disposal, place for tourism, font for crops irrigation, and floodwater reservoir. Despite the importance of rivers, the rapid growth of the economy and urbanization has produced a significant deterioration of these watercourses by contaminating the water with the discharged of nutrients, organic contaminants, and heavy metals (Yuan et al., 2013).

In 2002, the UN Secretary General presented surprising statistics that illustrates the significance of having high-quality drinking water. It was seen that "*An estimated 1.1 billion people lack access to safe drinking water, 2.5 billion people have no access to proper sanitation, and more than 5 million people die each year from water-related diseases — 10 times the number killed in wars, on average, each year. All too often, water is treated as an infinite free good. Yet even where supplies are sufficient or plentiful, they are increasingly at risk from pollution and rising demand. By 2025, two-thirds of the world's population is likely to live in countries with moderate or severe water shortages*" (Azizullah et al., 2010). These impacting numbers show the importance of water for the human kind and how this is a contemporary issue that needs to be mitigated.

Only 3% of the total water on the planet is fresh water, and only 0.01% of this fresh water can be utilised by human beings (Hinrichsen and Tacio, 2002, In Azizullah et al 2010). Unfortunately, even this small amount of available fresh water is notably declining due to urbanization and senseless consumption, while the human population is growing exponentially (Azizullah et al., 2010). Contaminants produced in industrial and mining areas can be easily transferred to other areas through surface water and groundwater, affecting with this, the environment and the life of humans and animals. In addition to this type of pollution, pesticides are spread on agricultural lands, contaminating the fields. It is said that fresh water has been polluted by human activities to such an extent that it cannot be restored to its original state (Törnqvist et al., 2010).
On the other hands, pharmaceuticals are emerging contaminants that are not yet regularised or which regulation is still in process (Daughton and Ternes, 1999 and Esplugas et al., 2007, In Sirés and Brillas 2011). These compounds are continuously being disposed into water bodies where they can be found at trace concentration (Jones et al., 2005, Sirés and Brillas 2011). As a result, this can lead to producing a negative impact on human and animal wellbeing as it alters the quality of water supplies (Sirés and Brillas, 2011).

Water pollution can be described as the incapacity of the water body to house the pollutants being disposed into the natural ecosystems. Depending on the source of pollution, water contamination can be divided into three groups which are industrial wastewater, agricultural discharges and municipal wastewater (Hu and Cheng, 2013).

2.6.3 Waste Pollution

Solid wastes are considered a phenomenon in urban territories. These are said to be produced due to the difference between the cost and the benefits of managing the waste materials and of the materials itself. These wastes are composed of urban trash, homogeneous materials such as food wastes, construction debris, industrial process wastes, and pathological wastes (Firdaus and Ahmad, 2010). This problem has been carried out since the beginning of human history. Human beings started the production of waste in the form of bones and woods. However, these wastes hardly represented a problem to humans of old communities due to the small quantities that were generated and could easily be degenerated by the environment or be washed away by rivers. In addition, waste started to be a problem when human civilisations started to engage in activities of production different from agriculture (Roy, 2003, In Firdaus and Ahmad 2010). In the beginning of waste management, civilisations from 300 to 1000 BC disposed solid waste into holes that were covered with a layer of soil (Dhere et al., 2008). Since then, the disposal of waste to land has become a relevant technique for waste dumping (Westlake, 2014).

During the 19th century, the generation of dangerous waste disposed into nature has substantially incremented, which led to the necessity of allocating the waste in a specific area. These areas are titled landfills and correspond to the most common way of dealing with waste today. In the UK, 28 million tonne of Municipal Solid Waste (MSW) is annually produced, from which 90% is discharged in landfills (Westlake, 2014).

The municipal solid waste (MSW) is composed of different types of materials which include metal, glass, paper, ashes and compostable materials. Additionally, some other wastes are considered as MSW but they are labelled as MSW2, these materials include hospital waste, paints, dead animals, unwanted chemicals, and agricultural waste. In addition, other substances like scrap materials, waste papers, dead animals, discarded chemicals, paints, hazardous hospital waste and agricultural residue are also categorized under MSW2 (Dhere et al., 2008).

On the other hand, E-Waste is different from the other forms of MSW or industrial waste. This is due to the composition of these materials which contain hazardous and valuable materials that require an efficient management to evade the pollution of the environment (Robinson, 2009). E-waste is composed of a significant variety of heavy metals, such as lead, cadmium, and copper. According to the composition of the materials, this waste possesses two types of substances which are categorized as hazardous and non-hazardous. Hazardous constituents include cadmium, chromium, lead, and mercury. On the other hand, non-hazardous materials embrace copper, selenium, zinc, silver, gold and platinum. Despite this classification, both substances represent a problem to the environment (Awasthi et al., 2015).

While recycling provides a sustainable method to recover the reusable components, it is normally not implemented in rich countries due to the environmental regulations, labour cost, and absence of facilities. Instead, it is exported to poor countries that lack environmental regulations, workers safety procedures, and required techniques (Cobbing, 2008, In Robinson 2009).

2.6.4 Air Pollution

It is proved by scientific studies that the exposure to particulate pollution can negatively affect the health of people by causing an aggravation to heart and lung diseases, irregular heartbeat problems, and respiratory symptoms (Giovanis, 2015). Although it is known that being in contact with this contamination is related to death and hospitalization from heart problems, the magnitude and effects produced in a long term exposure remain uncertain (Miller et al., 2007). The studies related to the demonstration of this link between cardiovascular mortality and air contamination is divided into two groups which are time series evaluations for short term effects and cohort studies relating the geographical areas to the level of contamination (Bauters and Bauters, 2015).

Some of the environmental air pollutions are caused by nature through a variety of physical activities such as volcanos and fire. However, the human race remains the responsible for the major sources of air contamination. The human activities that produce more air contamination are the transportation and the production of energy by burning fossil fuels. A variety of air pollutants has been discovered with a wide range of different properties such as reaction attributes, chemical composition, persistence in the air, ability to be carried, and their potential impact on humans and animals health (Kampa and Castanas, 2007).

These suspended particles have been categorized in accordance with the quantity per volume of air, and the most relevant suspended particles are the PM2.5 (diameter < 2.5 microns) and the PM10 (diameter < 10 microns), due to the facility in which they penetrate the respiratory system and the alveolar-capillary barrier (Bauters and Bauters, 2015). Furthermore, the worldwide premature deaths associated with air contamination raise to 2 million per year and more than half of these deaths occur in developing countries, which illustrates the critical environmental risk that this represents to human's health (Gurjar, 2010).

2.6.5 Biodiversity Loss

Biodiversity can be described as the quantity, abundance, distribution, composition, and connections of species, population, genotypes, and landscape units in a certain system. Humans are directly affected by biodiversity. The ecosystem services that provide benefits which enable and boost human life are directly influenced by biodiversity. In addition to the continuous delivery of a wide variety of organisms that are fundamental for cultural life and human material (Diaz et al., 2006).

Concerns rose over the degree at which species were disappearing from ecosystems during the 1980s. These worries led to the study of the influence of organism in the development of habitats, the flow of biochemical cycles, and the productivity of ecosystems (Cardinale et al., 2012).

It is said that species loss in ecosystems will produce an unbalanced that will impact the functioning and sustainability of ecological systems, as a result concerns have been rising due to the increasing loss of biological diversity (Danovaro et al., 2007). On the other hand, it has been reported that species loss in ecosystems will modify significant processes that are vital for the productivity and sustainability of the environment. However, the level of impact that this form of environmental change is affecting the ecosystems, in comparison with the other sources of change, is uncertain (Hooper et al., 2012).

Societies depend on biodiversity for many of the actions that subtend human life, a trait that is said to continue in the future. The diversity of organisms provides humans with the ability to produce fibres, food, medicine, and other sustainable resources. Additionally, throughout human history, biodiversity has represented an important element of the human experience, influencing human well-being. In the same way, biodiversity affects the planet's most crucial support systems with its influence on ecosystem processes and relevant materials that satisfactory subtend life (Diaz et al., 2006).

2.7 BUSINESS RESPONSE TO SUSTAINABILITY ISSUES

According to WCED (1987) sustainable development is defined as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs". It can be seen how in present times there is an on-going change on the ways of delivering projects and results. New policies and questions have rose to fight the new challenges the world is facing. One of these major challenges is sustainable growth. Due to the limited resources the world has, and the increase in the world's population, managers have been forced to take drastic measures on how to approach business. Although these changes need to be made, it is not an easy task to achieve it. The lack of knowledge towards the subject is one of the big barriers that have made sustainable growth a difficult thing to achieve.

In the early parts of the 21st century the word sustainability has become popular amongst many sectors. Dyllick and Hockerts (2002) and Renukappa *et al.* (2012) explain how although this concept has become widely known amongst many sectors, the concept of sustainability is rather a vague concept in the business sector. It is seen how although the word sustainability surrounds every definition of development in the 21st century, the concept aims rather to focus on an answer towards a more equitable and wealthy world focusing on society and environment and in most of the cases simply ignores an economic point of view. Following this, it can be stated that one of the greatest challenges that the concept of sustainability is the ongoing quest for economic growth.

It is stated by Nidumolu *et al.* (2009) that although there exists no alternative to sustainable development, most companies are convinced that becoming environmental-friendly results in high implementation costs and no actual immediate financial benefit exists. The main concern towards embedding sustainable strategies is the fear of falling behind in relation with other competitors due to the disadvantages of implementing "green" policies. These concerns are what gives us as result the fact that most executives treat the need of becoming sustainable as a social responsibility rather than as a business strategy.

Nevertheless, Laszlo and Zhexembayeva (2011) and Connor and Mackenzie-Smith (2003) explain how although some resistance exists, different factors have driven business leaders to pursue sustainable strategies; these factors include:

- The current economic and financial crisis.
- Increased demand and expectations from stakeholders.
- Protecting the existing natural resources.
- Increasing prices on basic services (E.G. energy price)
- Social and political pressures.

It is safe to say that sustainability is a complex matter and even though these drivers may exist, embedding sustainability within a business strategy is not an easy task. In order to address these factors, a sustainable approach has to be done from an organizational and institutional point of view. Following this, firms have been driven to pursue sustainability by integrating economical, ecological and social aspects (Dyllick and Hockerts, 2002). This integration is commonly known as the triple bottom line. What this integration pursues is to achieve the business aims, which according to Hayler and Nichols (2007) includes:

- Create compelling new products in order to maintain an advantage over the competition.
- Provide service quality and value as defined by customers.
- Generate attractive returns for all shareholders.
- Generate the best workplace for employers in order to maintain a confortable working environment.
- To act in an ethically, socially and environmentally responsible way.

In order to meet these aims, businesses have been forced to take a sustainable approach. This approach has resulted in the creation of new business models and at the same time in the creation of new policies and strategies in order to maintain a superior market position over the competitors. Park and Pavlovsky (2010) explain how a sustainable approach has helped reshape the rules of competition by redefining market structures and sectors and at the same time creating opportunity.

In order to compel with social, environmental and economical sustainability a clear definition of each needs to be taken into consideration. Baumgartner and Ebner (2010) define environmental sustainability as the effective management of the existing physical resources in order to assure their future preservation. Hopwood *et al.* (2005) explain how the concept of social sustainability has resulted from the growing awareness of organizations in relation to the existing socio-economic issues and from the need of tackling these issues in order to provide a healthy future for humanity. Anand and Sen (2000) define economic sustainability as the obligation to preserve the present day economic opportunities throughout time. Following these definitions it can be seen how the hardest aspect for a business is to maintain an economic sustainability. Businesses in present times are driven to embed social and environmental sustainability while at the same time trying to remain competitive in the market. Neubaum *et al.* (2009) explain how sustainability has forced managers to give the more importance to environmental and social responsibilities in order for them to be in line with the firm's economic concerns. Social and environmental aspects are no longer to be seen as a social concern but are now rather to be embedded in a firm's business strategy.

Although certain acceptation towards the term of sustainable development can be seen throughout different businesses, it is still safe to say that the most important point for a business is economic prosperity. Epstein *et al*. (2010) explain how the integration of the triple bottom line within a firm's business strategy is one of the biggest challenges that still exist and normally when it comes to investment in social and environmental responsibility many questions continue to rise. This is why some of the managers have started to see the implementation of sustainable strategies as an opportunity to achieve a competitive advantage over others, and the shift from a social responsibility to a business point of view is being made.

2.8 DRIVERS OF EMBEDDING SUSTAINABLE STRATEGIES AS A COMPETITIVE ADVANTAGE

Renukappa and Egbu (2007) point out eight main key drivers for embedding sustainable strategies that include:

1. Reducing Operating Costs.
2. Protecting or enhancing reputation.
3. Stakeholders Pressure.
4. Government regulations/legislation pressures.
5. Top management commitment.
6. Globalization.

7. Knowledge economy.
8. Socially responsible investment.

Reducing operating costs: Savitz and Weber (2007) explain how running a business is mainly focused on the following:

- Reducing operating costs.
- Improving productivity.
- Eliminating needless waste.
- Obtaining access to capital at lower cost.

Following this it can be said that the main aim within any organization is to produce a good or service at a low cost while at the same time generating profit and maintaining its commitment within society. In order to embed sustainable strategies as a competitive advantage firms have been driven to incorporate sustainable methods of reduction of costs within the business resulting in the reduction of costs while at the same time promoting sustainability. Eco-efficiency is an example of this type of strategies and is explained by Savitz and Weber (2007). The main goal of this is to reduce the resources used to produce a good or service in order to increase the profits while decreasing the environmental impact. The concept of eco-efficiency has become very popular throughout the years and is mainly based on eliminating unnecessary costs for something not being used. Côté *et al.* (2006) explain how firms interested in pursing eco-efficiency need to pursue one of the following:

- Reductions on the use of materials.
- Reductions on energy use.
- Reductions on the use of toxic substances.
- Promotion of recycling.
- Maximize the use of renewable resources.

- Extend the durability of products.
- Increase the quality of the services provided.

Some of the key drivers that address pursuing eco-efficiency can be seen in the figure below.

Internal drivers	External drivers
Cost reductions	Customer or consumer demand for "greener" products
Increases in the quality of products and services	Shareholders
Innovation	Access to capital
Increases in employee motivation	Competition
Personal commitment/responsibility to community	Government regulations
Management of risks and liabilities	Public pressure
Maintaining or increasing market share	Global pressures (climate change)

Table 2.1: Internal and external drivers of eco-efficiency.

Source: Côté et al. (2006).

Cramer (1999) explains how the success of these strategies depends on the following factors:

- The amount of environmental pressure imposed by external stakeholders.
- How much space to operate does the company has when regarding to implementation of new policies.
- The degree to which the company can use the environment as a competitive edge.

It can be seen how eco-efficiency is attractive not only for environmental reasons but it also helps to develop revenue. An example of this is the case stated by Savitz and Weber (2007) that is the case of STMicroelectronics, a Swiss based firm with revenues of 7.2 billions in 2003. It is explained how by investing 2% of its annual capital investments for environmental improvements the company has managed to reduce the electricity use by 28% and the water use by 45% with cost savings of 56 million in 2001, 100 million in 2002 and 133 million in 2003.

By applying these strategies, companies are able to reduce cost, while at the same time promoting sustainability, resulting in a better market positioning when compared to other competitors. The reduction in operating costs translates in a reduction in the cost of the final product.

Protecting or enhancing reputation: Fombrun and Van Riel (2004) explain how an enriched reputation and brand image in the construction industry can create a great positive impact in the existing business relationship and potential investors of the company. It is believed that a good reputation can help attract new partners and has a positive influence within customers and suppliers. Following this thought, companies have been driven to use the promotion of sustainable strategies within their operations in order to obtain a higher reputation in the market. Elkington (1994) explains how companies committed to understanding the importance of sustainable development are more likely to gain reputation than other companies due to the increasing concern of the topic by the world's population.

Carroll and Buchholtz (1996) explain how a firm's reputation can be defined as the perception of its relevant stakeholders including: owners, society and community, customers, employees, suppliers and partners, government and official agencies, financial institutions and non-governmental organizations (NGO's). Based on this it can be seen how a superior reputation in relation to the competition is an intangible asset and can be used as a competitive advantage in order to create value.

Fombrun (1996) explains how a company's reputation is a measure of its credibility, trustworthiness, reliability and responsibility. It is to be believed that firms who act in a socially and environmentally responsible manner have a competitive advantage over other firms regardless of the final product. Firms who enjoy of a positive reputation are to be trusted by all stakeholders due to the fact that lower risks are perceived and a better market positioning is expected.

Henriques and Sadorsky (1996) state that the most important driver addressing a company to pursue a better environmental reputation is the pressure perceived by many of its stakeholders that include: customers, shareholders, government and community groups. These use of a good reputation as a competitive advantage is a clear view on how sustainable strategies have helped managers to use environmental marketing to better satisfy their customers and other stakeholders. Environmental marketing is also used to help divulge the brand while at the same time satisfying the society and environment. The importance on the reputational advantages can be seen in the figure below.

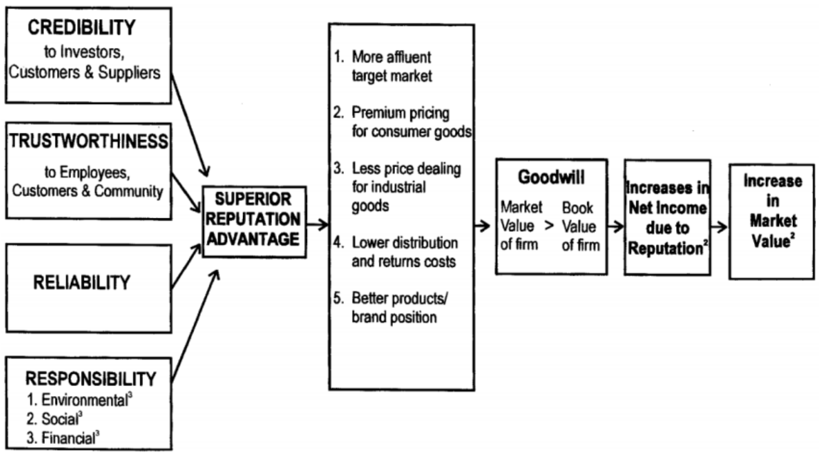


Figure 2.1: Importance of reputational advantage.

Source: Fombrun and Shanley (1990)

Stakeholders pressure: Freeman (1984) defines a stakeholder as “any group or individual who can affect or is affected by the achievement of the organization objectives” while Clarkson (1995) defines it as “persons or groups that have, or claim ownership, rights, or interests in a corporation and its activities, past, present or future”. Based on this it can be stated that a company’s success is driven by the satisfaction that exists within its stakeholders. With new legislations and new changes in the way of making business, society has forced firms to engage in social responsibility as part of their business model. Jones *et al.* (1980) explain how corporate social responsibility has become a part of the business and how it has become indispensable for the sustainable growth of a company. It is stated that what is mostly pursued in this policies is the preservation of the environment and human rights and at the same time the promotion of health and safety for the society. It is also believed that companies that engage in corporate social responsibility benefit form a higher reputation than others resulting in long-term sustainable growth.

Porter and Kramer (2006) explain how companies have reacted to outside pressures on corporate social responsibility and have started to set agendas that produce the maximum social benefit as well as a profit for the business instead of just reacting to the pressures with mere acts. The main aim is to benefit from these social pressures while at the same time generating a profit and positioning the firm in a better market position. The different activities that a company is engaged in while doing business can be seen in Figure 3. These activities can be used to create a framework in order to identify the positive and negative effects that may come from them in order to tackle all potential problems. This can help companies generate savings from avoiding potential problems while at the same time assisting with corporate social responsibility.

Hemingway and Maclagan (2004) state that although corporate social responsibility is driven by the stakeholders pressures, it is seen in some cases how the main driver behind these strategies is the changing personal values within the managers. What managers aim to do with this is to engage a new corporate image where it can be seen how corporate social responsibility is embedded within a firm's business strategy.

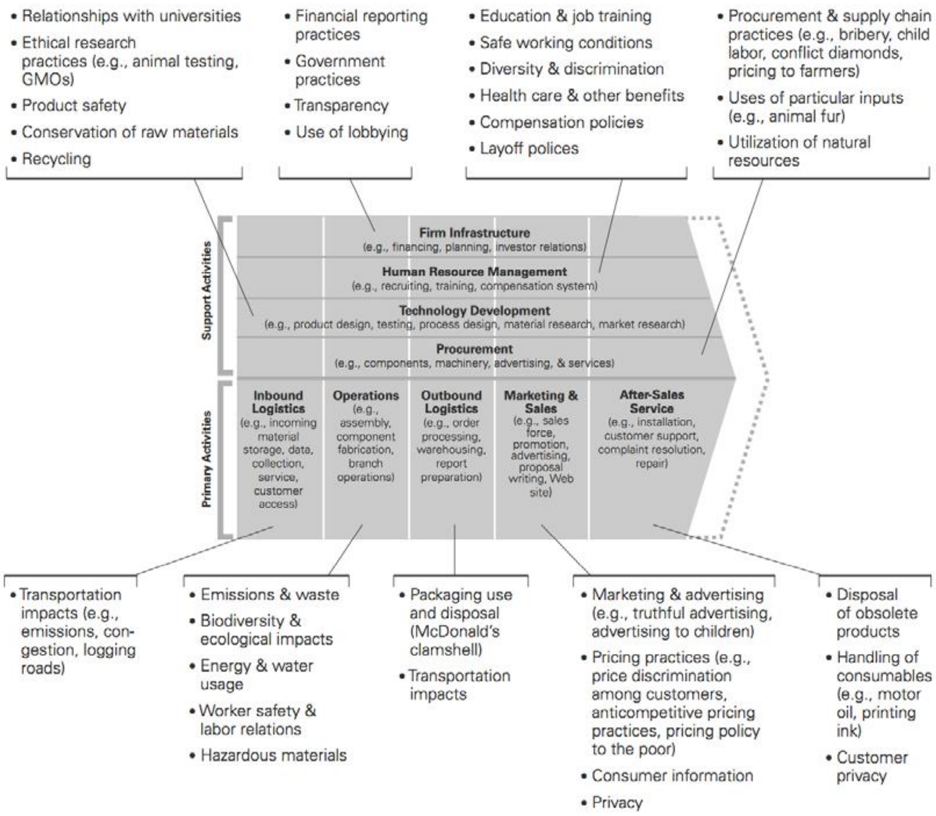


Figure 2.2: Value chain of corporate activities.
Source: Porter and Kramer (2006).

Government regulations/legislation pressures: Bromley (2007) explains how the economy is always regulated by government policy. In the past years it can be seen that the tendencies are to pursue social and environmental sustainability within all aspects of the economy. Haines *et al.* (2007) state that new policies are driven to pursue changes in order to accelerate access to clean energy, improve health conditions and mitigate climate change. The way for the government to pursue companies to do this is by the application of new laws and policies that force organizations to achieve certain goals in order to continue in business. This change has forced business manager to pursue new ways on how to use sustainable strategies as a business tool in order to avoid losses.

Dummett (2006) explains how senior managers are forced to make sure that programs are implemented in order to meet the government requirements and how most of the managers engage in this type of programs just to avoid any future threats that may rise from the government. On the contrary, Faruk (2002) explains in his study how 79% of 700 mostly UK based senior business managers surveyed said that government needed to encourage business to behave responsibly.

Although certain disagreement may exist between managers, it can be clearly seen how government legislation is one of the key drivers for businesses to pursue sustainable strategies. In order to achieve a competitive advantage by implementing these strategies, managers often seek for government incentives that exist within certain policies in order to obtain an economic benefit from this.

New government policies within the UK include:

- UK Climate Change Act 2008.
- Corporate Manslaughter and Corporate Homicide Act 2007.
- UK Landfill Tax Regulations 2010.

The main purpose of this acts and regulations is to pursue all economic sectors to effectively manage the existing resources and to pursue sustainable strategies as part of their business model.

Top management commitment: As it has been stated previously in this work, business organizations are being held responsible for the impacts of their operations within society and the environment. It can be seen how a shift exists on how organizations have fully adopted sustainability principles and how they have become embedded strategies within their business aims. Quinn *et al.* (2009) explain how organizations who have embedded sustainability within their top management positions often result in the most successful ones due to the fact that the management understands the idea and focuses on delivering it to all of the firm.

It can be seen how organizations that have top management commitment with sustainability eventually operate at a full level of sustainable strategies and find themselves in a better market position than the competitors. Doppelt (2009) states that leadership is the main key for organizations to embed sustainability. Good leadership helps to effective dialogue and change. According to Gloet (2006) effective leadership can surpass barriers that discourage the embedding of sustainable strategies such as past practices, old ideas and cultural frameworks.

Ulrich (1997) explains how the development of management strategies to support sustainability is crucial to the development of an organization and how this enables organizations to ensure ideas about ecology, sustainability and social justice within all branches of the organization. The Figure 2.3 shows an interactive table on how top management embedded with sustainability works within an organization.

Quinn *et al.* (2009) explain how creating an embedded sustainability within a business strategy is not an easy task to achieve. The process consists in a series of missions and visions of sustainability that aim to provide policies, structures and operations that will help to achieve a goal of embedded sustainable strategies. The different levels of embedded sustainability can be seen on the Figure 2.3.

ROLES

- Ability to work across organisational, national and international boundaries and disciplines
- Leader as visionary: the vision must support sustainability
- Demonstrate problem solving capacity across a wide range of complex issues, including environmental, technical, social, political and economic issues
- Role model – must be able to convince others of the positive impact of commitment to sustainability, and model behaviour accordingly
- Change manager – must be able to formulate a vision and 'sell' it, also reduce resistance to notions of sustainability
- Capacity to demonstrate and model self-renewing behaviour

RELATIONSHIPS

- Ability to think across boundaries, establish new relationships, work across value chains and across expanded markets
- Demonstrate excellent communication skills
- Capacity to build and maintain networks
- Capacity to broaden relationships, for instance not only across an organisation, but also consumers, suppliers, the value chain and the ecological chain.
- Able to collaborate widely
- Valuing principles of equity, justice, collaboration in all relationships
- Flexible and adaptive

Knowledge creation Knowledge sharing Knowledge dissemination Communication

CONTEXTUAL FACTORS

Processes Enablers Relationships Measurement Feedback Infrastructure

Self-awareness Learning Education Boundary spanning

STRATEGIC FOCUS

- Ability to implement sustainability strategies and plans across various levels
- Capacity for purpose driven leadership
- Understand need to set benchmarks and measure results
- Understanding the need to provide strategic leadership through the development of sustainable business models
- Delivers ROI for all stakeholders (as opposed to only shareholders)
- Ability to align business goals with sustainability goals and targets

Focus on renewal, revitalization in economic, social and environmental terms

LEARNING FOCUS

- Identifying ongoing, reflective, active learning opportunities
- Poses questions
- Engage in critical inquiry
- Values-aware
- Ability to pursue sustainability from an action learning orientation
- Ability to accelerate the learning curve to achieve results faster
- Systems thinker, seeing holistically
- Ability to recognise that all systems are fluid and evolving

Figure 2.3: Management capabilities to support sustainability.

Source: Gloet (2006).

Level of sustainability	Description
Pre-corporate sustainability	No ambition for corporate sustainability (CS); however, some activities toward CS might be initiated when forced from the outside (e.g. through legislation or a buyers strike)
Compliance-driven	Providing welfare to society, within the limits of regulations from the rightful authorities; organizations may respond to charity and stewardship concerns
Profit-driven	Integration of social, ethical, and ecological aspects into business operations and decision making, provided that it contributes to the bottom line
Caring	Consists of balancing economic, social, and ecological concerns, going beyond legal compliance and beyond profit considerations, motivation is that human potential, social responsibility and care for the planet are important
Synergistic	Consists of a search for well-balanced, functional solutions creating value in the economic, social and ecological realms of corporate performance with a synergistic, win-together approach with all relevant stakeholders
Holistic	Fully integrated and embedded in every aspect of the organization, aimed at contributing to the quality and continuation of life of every being and entity, now and in the future

Table 2.2: Levels of sustainability.

Source: Van Marrewijk and Werre (2003).

Globalization: Globalization can be considered as one of the most general drivers to embed sustainable strategies. Taylor and Theyel (2010) explain how organizations have been forced to redesign their business strategies due to the international competition that exists in every different market. Tisdell (2001) explains how with globalization new threats on the environment and on sustainable development existed. The main issue comes from the different ideas of sustainable development and the degree of commitment within the different countries. The imbalance created by globalization has caused growing concerns within organizations due to the lack of existence of a unified international policy.

In order to alleviate the problems generated by globalization, organizations have been forced to dedicate resources to reduce environmental and social impacts in order to comply with international standards. This case is mainly seen in developing countries where economic growth is superior than environmental and social awareness, therefore the environmental and social regulations are either weak or absent (Iizuka and Katz, 2015). All countries have been driven to adopt sustainable strategies as a competitive advantage in order to remain in the same market level as international competitors.

Knowledge economy: Drucker (1995) explains how "the single greatest challenge facing managers in the developed countries of the world is to raise the productivity of knowledge and service works". Throughout the past years it can be seen how knowledge has played an important role within organizations and has become one of the greatest assets to have. Knowledge economy is a clear example on how the economy is now driven by knowledge, skills and creativity. Organizations are driven to pursue new ideas in order to combine the exiting business strategies with sustainable development in order to maintain a higher market position. Bob (1999) explains how new policies have driven business to be innovative and creative in order to continuously improve performance while at the same time avoiding to get left behind in a fast changing economy.

Organizations in the world have been forced to demonstrate their corporate contribution to economic, social and environmental progress in order to alleviate the high existing demands against them due to their alleged negative impact (Wiek *et al*., 2011).

Socially responsible investment: Munoz-Torres *et al.* (2004) define socially responsible investment as "investment enabling investors to combine financial objectives with social values". Vakhidova (2012) explains how socially responsible investment is a way to encourage business to pursue sustainability. The main idea is to explore the potential social business opportunity that may exist in order to contribute to society while at the same time generating a profit. These type of investment aims to lure investors who are generally interested in social or environmental projects. The main aim is to maximize the social benefits, while reducing environmental impact and at the same time generating a profit.

By pursuing this investment, organizations are trying to explore a new way of business that has yet to be exploited. This is why it can be seen how there exists a growing interest towards the subject. Renneboog *et al.* (2011) explain in their study how although some negative aspects surrounding the term exists from the past, investors are still pursuing these investments due to the social and environmental benefits they promote. This is why many organizations have pursued socially responsible investment as a sustainable strategy in order to achieve a competitive advantage. Although the investors do not generate an economic profit, funding to the organization persists as long as they can assure a social and economic benefit.

Socially responsible investment has become a trend in many organizations to the point of developing "green" products in replacement of existing ones in order to promote social and environmental welfare. Socially responsible investment is to be seen as the idea that organizations take into consideration all of their stakeholders when making an investment, resulting in a final product or service that serves the need of all stakeholders while at the same time protecting the environment.

2.9 CHALLENGES OF EMBEDDING SUSTAINABLE STRATEGIES AS A COMPETITIVE ADVANTAGE

Berns *et al.* (2009) confirms how organizations are not fully convinced when deciding to adopt sustainable strategies in their business goals or not. It is seen how organizations often lack of the right information on which to base their decisions, which makes it a difficult case for managers in order to avoid potential losses. Besides this, a business case for value creation in most cases is not defined, therefore a lack of direction can be seen as to what objectives pursue. Most importantly, when deciding to pursue sustainable strategies as a competitive advantage, organizations are often misguided resulting in poor execution of the strategies therefore not generating any important benefit.

Laszlo and Zhexembayeva (2011) explain how the lack of awareness on the subject, and the constant failure when trying to pursue these strategies has resulted in a pattern among many organizations in which organization remain with the traditional approaches as an answer to alleviate the existing pressures and only embed general strategies as a way of merely serving the corporate social responsibility.

It is stated by Du Plessis (2002) that one of the biggest challenges that sustainability faces is the lack of education. Ignorance and lack of information towards certain subjects has resulted in a state of fear throughout many organizations. In most cases, sustainable strategies are not often seen as a business strategy because of the lack of information obtained by managers, resulting in a business that merely competes on economic levels and can be easily moved from their market position by a new business with new strategies. Many organizations incur in the fear of change and remain with traditional business strategies in order to remain in the market. It can be clearly seen how some organizations do not know what sustainability is and what it means to them in terms of business. Berns *et al.* (2009) explain the main reasons of this which include:

- Managers commonly lack of direction when deciding what drivers and issues are relevant to their organization.
- Organizations commonly do not have a clear idea or definition of what is sustainability within their firm resulting in general misguidance and different opinions within the same organization.

- Organizations are not commonly aware of what could be the potential benefits and generally are not able to measure their progress in any way once actions have been taken, resulting in a loss of interest because no progress can be seen.

Hart (1997) explains how the need of survival in emerging economies in the world is often seen as a major challenge to sustainability. Although it is stated by Berns *et al.* (2009) that well implemented sustainable strategies result in massive benefits, the implementation of these strategies are commonly associated with high costs. Emerging economies throughout the world are commonly unable to pursue sustainability.

Although general challenges may exist to embed sustainability within all organizations, these may vary in accordance as to the specific financial activity in which the firm incurs. Shen and Zhang (2002) explain how the construction industry has always generated negative impacts on resources, living and working environments. The main concern amongst most contractors is the profitability of being sustainable. Many issues rise when pursuing embedded sustainability within construction organizations that according to Opoku and Ahmed (2015) include:

- Lack of understanding towards the subject.
- Embedding sustainable strategies results in higher construction costs.
- Negative perspective towards the subject due to high costs for implementation.
- Embedding sustainable strategies results in new contracts requirements and procurement practices.
- Lack of interest from the client due to high cost.
- Lack of skilled workers on sustainable construction.

The general constraints that exists when pursuing to embed sustainable strategies within an organization are stated by Harwood and Humby (2008) and are:

1. High cost of implementing sustainable strategies.
2. Priority over other investments within the organization.
3. Initiative overload.
4. Cynicism towards believing that the idea is being promoted for self-benefit.
5. General fear towards change.
6. General believe that the problem belongs to somebody else.
7. Limited success stories.
8. Limited rewards mechanisms.
9. Conflicts between corporate responsibility and value for money in procurement decisions.
10. Lack of knowledge on how to measure progress.
11. Competitive market due to globalization.
12. Lack of a unified definition of the term sustainability.
13. Persistent stakeholders demand for profits.
14. Uncertainty over what sustainability requires.

2.10 BENEFITS OF EMBEDDING SUSTAINABLE STRATEGIES AS A COMPETITIVE ADVANTAGE

According to Laszlo and Zhexembayeva (2011) pursuing embedded sustainability has resulted in the creation of business value. It is stated that firms have managed to save millions of dollars by understanding the benefits of embedding this type of strategies within the business strategy of the organization.

Berns *et al.* (2009) explain how when companies take sustainability as a serious matter and start to embed sustainable strategies within the core of the organizations business strategy they tend to discover new opportunities on how to reduce costs, create new revenue streams and find new ways of how to innovate within the organization.

Sustainability has become vastly important in business these days. It can be seen how everyday most organizations are trying to pursue these types of strategies in order to achieve a new business strategy that will enable them to obtain a competitive advantage over other organizations. Throughout their study, Berns *et al.* (2009) state that when interviewing different organization leaders, the main benefits that were obtained while pursuing sustainable strategies included:

- Improved image of the organization or brand.
- Major cost savings.
- Competitive advantage.
- Employee satisfaction, morale or retention.
- Product, service or market innovation.
- Business model or process innovation.
- New sources of revenue or cash flow.
- Effective risk management.
- Enhanced stakeholder relations.

Savitz and Weber (2007) explain how the business of sustainability can improve management in three fundamental ways:

1. Protecting the business: By embedding sustainable strategies organizations are able to reduce the risk to society and the environment. The main idea is to

protect the organization from any potential problem by establishing policies in order to identify potential risks or management failure early in time.

2. Running the business: By embedding sustainable strategies organizations are able to reduce costs, improve productivity and eliminate needless waste. The main idea is to promote the necessary savings within different branches of the organization in order to achieve better results with fewer resources. Organizations are also able to produce benefits from new ideas that may rise while embedding sustainability.
3. Growing the business: By embedding sustainable strategies organizations are able to explore new markets, launch new products or services and introduce innovation as a core business strategy. The main strategy is to grow the market by persuading stakeholders for whom sustainability has a personal or business value. By doing this, organizations are able to expand their market position while at the same time improving their image.

2.11 ORGANIZATIONS THAT HAVE EMBEDDED SUSTAINABLE STRATEGIES AS A COMPETITIVE ADVANTAGE

Berns *et al*. (2009) explains how although most of the companies throughout the world have yet to embed sustainable strategies within their business objectives, there are some key examples of organizations that have been successful by doing so.

Barthorpe *et al.* (2004) explain in their study how most of the construction firms have embedded sustainable strategies in order to promote corporate social responsibility. A list of the strategies can be seen on the table below.

UK Contractor	Examples of CSR initiatives
George Wimpey www.wimpey.co.uk	Local and national charity support and donations. Commitment to environmental and sustainable construction.
Laing Group www.laing.com	National BITC Excellence Award for providing training centres for local and disadvantaged people in London. Financial donations.
Bovis www.bovis.com	Community Foundation established in 1983. Annual Global Community Day established in 1996 requiring employees to set aside a day each year to demonstrate practical care for the community.
Taylor Woodrow www.taylorwoodrow.com	Community policy emphasising holistic application of CSR principles at head office and at project level for the local community.
Costain www.costainco.uk	'Community Chest' initiative established to encourage employees themselves to utilise corporate grants and donations budget in the community.
Lovell Partnerships www.lovellpartnerships.co.uk	Sponsored events organised to support local charities. Goodwill building projects in local community. Crime prevention initiatives.
Carillion www.carillionplc.com	BITC Company of the Year 2003 award for sustainability and environmental issues.
Interserve www.interserveplc.co.uk	Site-based auctions to support local charities. Education progammes and Arts Council links with schools. Environmental sensitivity at project level.

Table 2.3: Corporate social responsibility initiatives by UK contractors.

Source: Barthorpe et al. (2004)

Other organizations that have embedded sustainable strategies as a competitive advantage in a higher level include Carillion and Lafarge Tarmac. Both of their strategies and progress can be seen in the Tables 2.4 and 2.5 below.

CARILLION PLC	
Target	**Measures**
Building a successful business.	• Reductions in cost and increase profitability by £32.5 million in 2015 and by £40 million in 2020.
Enabling low-carbon economies	• Reducing carbon footprint by 20% in 2015 and by 24% in 2020. (Against a 2011 baseline) • Reducing gas consumption from Carillion offices by 20% in 2015. • Reducing electricity consumption from Carillion offices by 20% in 2015. • To increase % of contracts that have a Carbon Reduction Plan to a 100% by 2015.
Protecting the Environment	• To increase the % of waste diverted from landfill to a 98% zero waste in 2015 and a zero waste to landfill in subsequent years. • To reduce water consumption by 25% in 2015. • To increase the % of timber that meets FSC or equivalent standard by 100% in 2015.
Supporting Sustainable Communities	• To increase % of local spend including SMEs in the UK to 60% by 2015. • To increase % of Carillion apprentices who complete their framework having an employment outcome by 90% in 2015 and by 95% in 2020. • To increase % of contracts having a Community Needs Plan by 100% in 2015. • To target 1% of pre-tax profits to donations to community activities either in cash or kind.
Providing better prospects for our people.	• Increase in % of reduction in All Accident Frequency Rate by 56% in 2015 and 70% by 2020. • To increase % of employees that feel proud to be part of Carillion by 75% in 2015 and by 80% in 2020. • To increase % of employees that utilize the Carillion special leave policy for community engagement in areas where we work by 22% in 2015 and by 50% in 2020.
Leading the way with our customers and suppliers.	• To increase % of suppliers that respond positively to sourcing materials and products from responsible and ethical sources by 40% in 2015 and by 100% in 2020.

Table 2.4: Embedded sustainable strategies from Carillion PLC

Source: Carillion PLC (2015)

According to Carillion PLC (2015) it can be seen how by embedding sustainable strategies the organization has been able to generate more revenues and at the same time maintaining a superior level over other construction companies in the UK. However, in

2017, the company ran into substantial difficulties and ultimately failed. The collapse of Carillion can be attributed to a range of factors, many resulting from the strategy employed by the company itself. Carillion became over-stretched, highly leveraged and, through under-bidding, left itself highly exposed to adverse outcomes on a small number of construction projects – risks exacerbated by aggressive accounting, mismanagement of pensions and prioritisation of dividend payments at all costs.

Carillion’s business model was an unsustainable dash for cash. The mystery is not that it collapsed, but how it kept going for so long. Carillion’s acquisitions lacked a coherent strategy beyond removing competitors from the market, yet failed to generate higher margins. Purchases were funded through rising debt and stored up pensions problems for the future. Similarly, expansions into overseas markets were driven by optimism rather than any strategic expertise. Carillion’s directors blamed a few rogue contracts in alien business environments, such as with Msheireb Properties in Qatar, for the company’s demise. But if they had had their way, they would have won 13 contracts in that country. The truth is that, in acquisitions, debt and international expansion, Carillion became increasingly reckless in the pursuit of growth. In doing so, it had scant regard for long-term sustainability or the impact on employees, pensioners and suppliers.

Another organization that has been successful while embedding sustainable strategies as a competitive advantage is LAFARGE TARMAC. Their sustainable strategies follow four key themes each of them with a specific priority and can be seen below.

KEY PRIORITIES	COMMITMENT	2020 MILESTONE
SAFETY AND HEALTH	Zero harm	Achieve zero harm
OUR PEOPLE	An employer of choice	Achieve top 10% in the industrial sector for employee engagement and well-being in regular employee surveys
COMMUNITY INVOLVEMENT	Net positive contribution to our communities	Contribute 50,000 volunteer hours per year (or one day per employee)
CLIMATE CHANGE	Design CO_2 out of our products and services	37% reduction in CO_2 per tonne of product compared to 1990 (i.e. 15% compared to 2013)
ENVIRONMENTAL STEWARDSHIP	Net positive biodiversity contribution	100% of mineral extraction sites to have Biodiversity, Geodiversity and Restoration Management Plans
RESOURCE EFFICIENCY	Accelerate the transition to a circular economy	Recycle over 10 million tonnes a year of waste and secondary materials from other sectors
ECONOMIC VALUE	Create sustainable economic value	Invest in future construction solutions
GOVERNANCE AND ETHICS	Uphold the highest corporate governance and ethical standards	Continue to achieve 100% compliance with Lafarge Tarmac's code of conduct and competition compliance programme
COMMUNICATION	Be recognised as the preferred choice for sustainable construction solutions	Communicate performance through an independently verified, Global Reporting Initiative compliant sustainability report
SUSTAINABLE SUPPLY CHAIN	Responsibly procure all goods and services	Ensure supply chain partners are selected against responsible and ethical sourcing criteria using the principles of BS 8903
INNOVATION AND QUALITY	Develop next generation sustainable solutions	Establish Lafarge Tarmac centres of excellence with universities and research bodies
SUSTAINABLE CONSTRUCTION	Enable customers to use innovative solutions to create a sustainable built environment	Provide industry leading guidance and solutions that optimise whole life performance

Table 2.5: Key priorities, commitment and milestones for embedded sustainable strategies for LAFARGE TARMAC.

Source: LAFARGE TARMAC (2014).

Sustainability in developing countries: Throughout the report, it can be seen how embedding sustainable strategies can result in a competitive advantage over other firms. Although this can be stated, it is safe to say that these types of strategies are more efficient in developed countries. Countries in ways of development such as the UAE suffer from challenges bigger than countries such as the UK because of the barriers that exist in the different economies. Du Plessis (2002) explains in its report the following challenges that developing countries face when trying to pursue sustainability:

- The need of a new development model: developing countries often find themselves in rapid economic growth and in most times this growth results in environmental harms or problems within society. This growth is driven by the necessity of consume and development that exists within developing countries. Trying to imitate models from more developed countries is almost impossible because of the existing needs. Developing countries need to find a model that helps to promote economic growth without deteriorating the environment.

- Urbanization and urban development: Economic and population growth result in the need for bigger infrastructures in sectors such as transportation and tourism. The present need overcomes any potential future damage that may occur and in most cases the environment and society are completely ignored. Because of the lacks of funds new infrastructures commonly ignore sustainability resulting in a system that is not viable for the future.
- Sustainability in housing: Due to the rapid economic growth sustainability in housing projects is mostly ignored. This is mainly due to the fact that no extensive policies exists and if taken into consideration the price of housing in developing countries is normally high compared to the economic situation of most of society.
- Education: Ignorance and lack of information towards the term sustainability is common in developing countries. This is one of the major obstacles that are yet to be overcome. The term is commonly misused and no real importance is given to it.
- Innovation in building materials: Because of the lack of resources, the materials used for building and industry are commonly the cheapest one, not taken into consideration and possible harm to society or environment.
- Financing and procurement: developing countries are in need of a financing program that encourages eco-friendly organizations.
- Governance and management: the level of interaction between the government and the term sustainability has to change dramatically. Governments in developing countries constantly ignore the case because no actual funding can be dedicated to the area.

2.12 SUMMARY

Throughout this chapter the importance of embedded sustainability could be seen. Embedded sustainability is defined by Laszlo and Zhexembayeva (2011) as the incorporation of environmental, health and social value into core business activities with no trade off in price or quality. The main aim of embedding sustainable strategies into business activities is to achieve a competitive advantage over other firms by achieving leverage over the new global challenges that exist to assure long-term profitability and growth.

It could be seen how although general resistance exists to the change, several factors such as the current economical and financial crisis, increased demand and expectations from stakeholders, protecting of the existing natural resource, increasing prices on basic services (e.g. energy price) and social and political pressures have driven organisations to start pursuing sustainable strategies within their business objectives. The purpose of this is to gain advantage over other organisations against an imminent change in the way of doing business.

Throughout the literature review, the main drivers addressing organisations to embed sustainable strategies within their firm that could be found include:

1. Reducing Operating Costs.
2. Protecting or enhancing reputation.
3. Stakeholders Pressure.
4. Government regulations/legislation pressures.
5. Top management commitment.
6. Globalization.

7. Knowledge economy.
8. Socially responsible investment.

One of the greatest challenges that could be found towards the subject is education. Throughout the literature it could be seen that managers commonly lack of direction when deciding what drivers and issues are relevant to their organization and this has resulted in an extreme challenge towards the subject. Organizations are not commonly aware of what could be the potential benefits and generally are not able to measure their progress in any way once actions have been taken, resulting in a loss of interest because no progress can be seen.

Amongst the benefits it could be seen how organizations how embed these type of strategies often obtain rewards such as: an improved image of the organization, reduction in costs, better marketing position and satisfaction amongst all stakeholders.

It could be seen how major organizations such as Carillion PLC and Lafarge tarmac have extensive sustainability strategies that have helped them achieve a great market positioning. It is seen how the embedding sustainable strategies has helped them position themselves in a higher level than other firms, offering clients new products and services that have risen from markets that have emerged due to sustainability policies.

The most important discovery through the literature is that although it could be seen how sustainable strategies do result in a competitive advantage over other firms, developing countries mostly do not pursue these strategies due to economic or social issues. It could be seen how constantly the lack of interest towards the subject results in negative environmental impact. It can be seen how although the benefits of embedding sustainable strategies as a competitive advantage are the same in every part of the world, not all organization pursue these types of strategies.

The objective achieved during this stage was to identify the drivers, challenges and benefits towards embedding sustainable strategies as a competitive advantage for firms in the UAE construction industry focused on an environmental, social and economic point of view through a detailed review of the available resources such as: journals, conference papers, textbooks, magazine articles, among others.

The next chapter (i.e. Chapter 3) will discusses the most important aspects of Building Information Modelling, green construction and mobile technology and cloud computing.

CHAPTER 3 : LITERATURE REVIEW ON DIGITAL TECHNOLOGIES

3.1 INTRODUCTION

In this section is provided a comprehensive and objective view of the background literature related to the aim and objectives of the project. Therefore, this chapter focuses primarily on the topics Building Information Modelling, green and sustainable construction, mobile applications, and application of BIM in sustainable construction. Also, it presents the results of previous studies about triggers, drivers and barriers for the current and future use of BIM on Green projects.

3.2 BUILDING INFORMATION MODELLING

The primary vendor for BIM computer design software, Bentley Systems, define BIM as a way of approaching the design and documentation of construction projects, sustainable or not, which is applicable throughout the project life cycle (design, construction and operation), with the ability to store all the information produced during these different stages, and also allowing the generation of modelling and simulation of the building, letting make a prediction of the behaviour of the building at the time of his delivery and operation, using integrated tools (Castagna, 2008). BIM is perfectly suited, allowing the supply of information necessary to optimise the design and building operation (Wong and Qing, 2013).

There is no exact date for the first time that the BIM terminology was used, thanks to it was used by different sectors across the world at the same time. America claims to be its creator in 2002, when they used to describe architectural designs, and management of constructions and buildings (Race, 2013). The rapid development of Building Information Modelling in the last years has changed the traditional practices in the fields of architecture, engineering and construction. BIM is a proposal for common use in a project that allows the groups responsible for the construction/infrastructure monitor the construction process and manage the facilities, work seamlessly and effectively. The project stakeholders, such as designers and builders, can share information through BIM applications so they can solve problems that may arise in the design and construction phases in advance (Wong and Kuan, 2014).

The BIM methodology due to its structure allows to develop new ways of sharing information and collaborates with the communication between the stakeholders of a project (Wong and Qing, 2013). The main objective of BIM is to facilitate the processes of documentation and design of a building, facilitate the construction management, and provide better management capabilities to the building owner during the occupancy stage (Moakher and Pimpiklar, 2012).

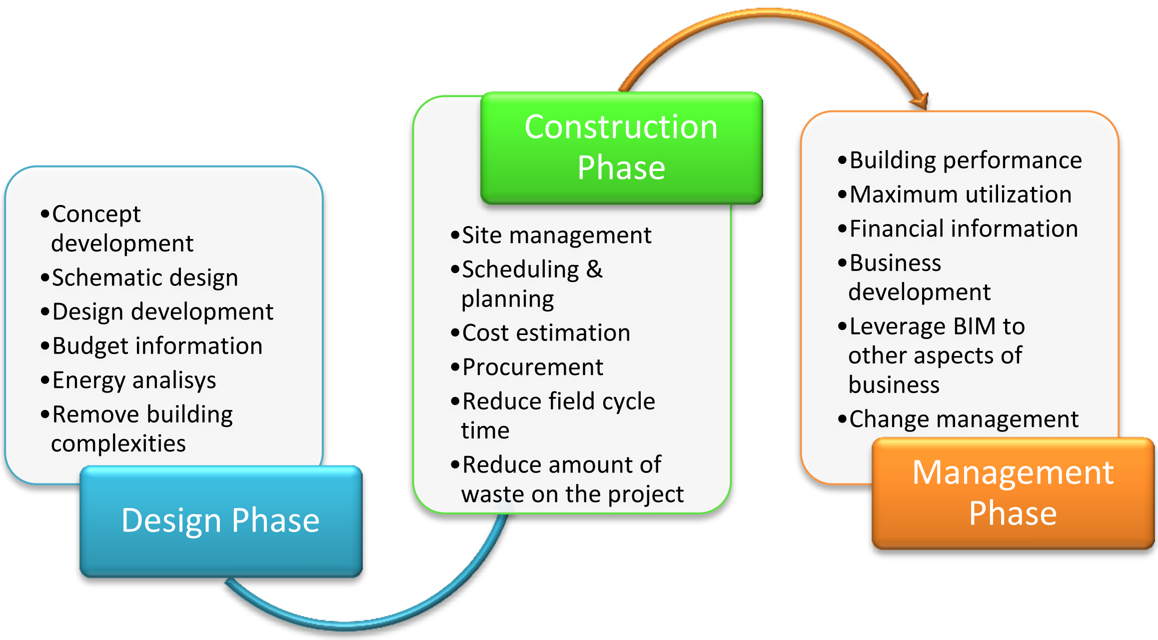


Figure 3.1: BIM processes

The qualities that make it attractive is that BIM allows the management of information throughout the lifecycle of a project, increased efficiency, 3D views that fully meet customer expectations, material supplier integration, and eventually as a final result, a better design (Khosrowshahi and Arayici, 2012).

Integrated project delivery

Inefficiency and waste are the main factors impeding sustainable development in construction. Forms of conventional design and documentation reveal the need for constant improvement. Within the team of a project is essential the communication of ideas and information for the entire staff be aware of any adjustments in the project. However, by implementing integrated project delivery as a tool for BIM is possible improve internal communication, and invest more time in the quality of the construction (Wong and Qing, 2013).

Integrated project delivery (IPD) is defined by The American Institute of Architects (AIA, 2007) as *“a project delivery approach that integrates people, systems, business structures, and practices into a process that collaboratively harnesses the talents and insights of all project participants to optimise project results, increase value to the owner, reduce waste, and maximise efficiency through all phases of design, fabrication and construction”.* This is a process where all stakeholders in the project are benefited with a more rational use of resources, and because it is due an integrated work can be achieved an innovative project (Sive, 2009).

The union between integrated project delivery and BIM can help to reduce the time of a project, which is reflected in lower costs, improved quality and better performance during the life cycle. Also it has the advantage of allowing incorporate sustainability in a more simple way. Sustainable construction is possible thanks to the decrease of rework and decreased production of waste materials (Wong and Qing, 2013). This link also allows to observe the project from another point of view, contributing to efficiency and the reduction of errors (Porwal and Hewage, 2013). Integrated project delivery is the integration, cooperation and participation in the working team to streamline processes and improve the final product. With IPD are achieved constructions cheaper, less risky, and most beneficial for the project and the customer (Sive, 2009).

As every new methodology, IPD has limitations that do not allow a faster adoption in the field of construction. Within these obstacles, the main barrier is the opposition to change; because many industries prefer to keep their conventional mode of leadership, responsibility and opportunities management, and not adopting new ways of working even prove to be beneficial to all the parties involved in those projects (Porwal and Hewage, 2013). The three main obstacles for IPD development are: its structure for facilitation, contracts and insurances (Fish and Keen, 2012). Ghassemi and Becerik-Gerber (2010), also mentioned cultural barriers do not allow the industry to change from one method to another.

Design optimization

BIM allows knowing and evaluating the performance of a building from the design and preconstruction phases, as well as knowledge about the shape of the building, materials, context, and technical systems required, enabling sustainable measures and analyses performance during entire process (Azhar et al., 2010). BIM helps design optimization allowing architects made and discuss several design alternatives simultaneously within a single model. Design options can be alternated, quantified and analysed as many times as needed, and can be archived for the required time, also incorporated, discarded and archived until a decision is made (Autdesk, 2005).

3.2.1 BIM ADOPTION AND BENEFITS

BIM represents a new approach in the design and construction of projects with high development potential for industries in the future (Krygiel and Nies, 2008). BIM offers to the world of construction more benefits than just make more efficient and effective the construction processes (Barnes and Davies, 2014). According to Klaschka (2014), among drivers that help the adoption of BIM is the increase in efficiency and profit, and enhancing working methods.

The correct application of BIM during the stages of design allows more rational decision making due to increasing the quality and the accessibility to design data (Wong and Qing, 2013).

Environmental aspect: As previously discussed the joint application of tools such as integrated project delivery and design optimization, is recognized by the effectiveness in reducing the consumption of energy and materials. Other solutions can be created under the criteria of BIM for better performance in the construction, and to avoid the bad consumption of resources, produced by the inefficiencies and mismanagement of projects.

Social aspect: Again plays an important role the Integrated Project Delivery (IPD) reducing the potential risks in the construction, using improvements in communication and collaboration between project members. Also improvements occur in safety, because the risks are set out in the planning stage. The improvements made in the quality of design and construction contribute to improving the living environment of future users.

Economic aspect: As mentioned in the previous section, with integrated project delivery can be foresee possible risks, and thereby anticipate problems. With this, through better management of the construction decreases the amount of waste and therefore reduces the cost of the project. With respect to the design optimization, are lower the capital necessary for construction and maintenance costs over its life cycle, by being energy efficient.

Industrialised countries such as China and Japan have seen the necessity of applying BIM in the different stages of its construction, implementing standards with which to raise awareness of its importance and benefits, although nowadays its adoption is slow (Race, 2013). Using BIM as a methodology allows successful results due to changes in the structuring of the project and design expectations (Krygiel and Nies, 2008). However, it is unknown between the UK and the USA which country is most advanced in terms of BIM adoption. The governments of both countries are striving to become the leaders in the implementation of BIM in the construction industry (Race, 2013).

As shown in the graph presented below, BIM awareness is becoming a trend in the UK. It has gone from 58% in 2010 to 95% in 2013, making it clear that by 2013 only 5% of research participants were unaware of BIM. But not only the awareness has grown, its adoption has gradually grown. For 2010, BIM had few practitioners, evolving so significantly that for 2013 was already applied in 54% of construction projects in the UK. Notwithstanding the UK Government has required the use of BIM for publicly-funded projects by 2016, can be appreciated in 2014, which a small decline is presented in the adoption of BIM. Specialists believe that BIM is at the midpoint of the adoption curve, and that its growth will be faster in the coming years.

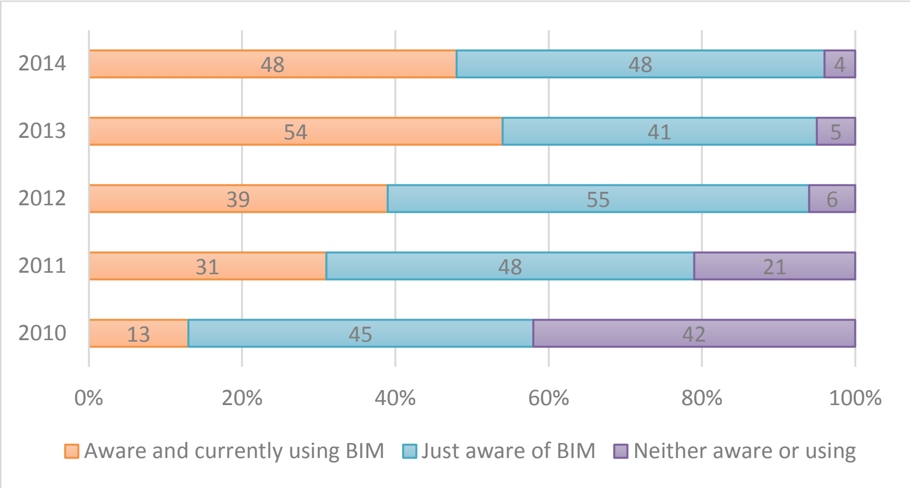


Figure 3.2: BIM usage and awareness over the time in the UK

Source: National BIM Report (2015)

3.2.2 CHALLENGES AND BARRIERS FOR BIM IMPLEMENTATION

In spite of all the benefits obtained from the use of BIM, there are still obstacles that prevent it a greater acceptance in the field of construction. People accustomed to working with 2D CAD projects tend to reject the change to more advanced software, because that means learning how to handle this technology from the beginning. This causes the resistance of employees who are not willing to implement changes in their way of working, and those who are not interested in learning new skills (Klaschka, 2014).

Some companies believe that among the barriers to acceptance of BIM is that end benefits do not outweigh the costs involved in putting it into practice, there is not enough demand and it turns out to be an investment too risky (Khosrowshahi and Arayici, 2012). BIM software are very costly. In addition to this, must be added that software as plaintiffs require higher capacity hardware, which involves making sure that the system can run the software or otherwise make an update to the specifications (Klaschka, 2014).

Main Barriers	**Percentages**
Lack of in-house expertise	74%
Lack of training	67%
No client demand	63%
Cost	56%
No time to get up to speed	51%
Some projects are too small	43%
Lack of standardised tools and protocols	41%
BIM is not relevant to the project	37%
Lack of collaboration	31%
BIM is not a strategic priority for the company	27%
Liability concerns	20%
Lack of freely available BIM objects	17%
Lack of high quality, information-rich BIM objects	17%
Do not see the benefits	17%
Managers are no sure that the industry will adopt BIM	16%
Managers are unsure of the Government´s commitment to BIM	11%

Table 3.1: BIM adoption barriers
Source: National BIM Report (2015)

In the NBS – National BIM Report (2015), can be found a study conducted to identify the main barriers that prevent the adoption of BIM successfully. The results of this study show that the main barriers facing BIM in the UK, is the lack of experience and lack of training in the area. While the Government requires the implementation of BIM, customers do not, which stands as the third barrier in the way of BIM and its full adoption. The costs are still a barrier of great importance, but this time because the workloads increase, the time factor becomes crucial for designers. But despite all of this only 16% of respondents are not sure that the industry will adopt BIM, and 11% are sceptical of the government's commitment to BIM.

3.3 SUSTAINABLE AND GREEN CONSTRUCTION

The rapid development of society and technology has led to the deterioration of the physical environment of the planet. The construction is part of the factors that cause environmental degradation (Wong and Qing, 2013). With the construction, the amount of agricultural areas and vegetation is decreased, the air pollution is caused, and besides that is a major user of non-renewable energy sources and minerals (Spence and Mulligan, 1995). Speak about emissions from buildings; consist generally in resource consumption and greenhouse gases production, by activities of daily living of people. Research shows that the building area is the largest emitter of greenhouse gases. The 70% of emissions are produced by the global construction industry and end areas, mainly for the production of materials and the use of facilities (Li et al., 2014). Data published by the U.S. Green Building Council in 2009, show that US buildings are responsible for 30% of world energy consumption, and the 48% of the greenhouse gases production in the United States.

Between 1997 and 2020 an increase of 2.7% in world energy consumption is expected. The construction of large-scale infrastructure project play an important role in sustainability, because its magnitude can cause severe and irreparable damage to the various ecosystems that interact in the environment, consequently is required a more detailed and careful planning in conventional buildings. The situations that have been previously described require the application of a methodology to extend the life cycle of buildings, and reduce environmental disturbances (Andreas et al., 2010). Green building development fully achieves the reduction of CO_2 emissions and helps to alleviate the energy crisis (Li et al., 2014).

"Sustainability" and "Green" are terms that have been evolving within the field of construction throughout the 21st century (Andreas et al., 2010). The National Association of Homebuilders (2006), define Green Building like *"The process of building that incorporates environmental considerations into every phase of the homebuilding process. That means that during the design, construction, and operation of a home, energy and water efficiency, lot development, resource-efficient building design and materials, indoor environmental quality, homeowner maintenance, and the home's overall impacts on the environment are all taken into account".* Kibert (2013) simplifies this definition to refer to a Green Building, such as building with the quality and characteristics which establish the principles and methodologies of sustainable construction.

"Principles of Sustainable Construction:

1. Reduce resource consumption (reduce).
2. Reuse resources (reuse).
3. Use recyclable resources (recycle).
4. Protect nature (nature).
5. Eliminate toxics (toxics).
6. Apply life-cycle costing (economics).
7. Focus on quality (quality)."

Nevertheless there is no precise definition for sustainable construction, but The Hong Kong Housing Authority, described as a balance between environmental, social and economic aspects. That is, construct using the least amount of natural resources, and causing a minimal damage to the environment. Providing a safe environment for residents, people working in the construction, and project managers, as well as build cost-effectively, keeping our operating costs at a minimum (Lee, 2008).

Andreas et al. (2010), supports the perspective of The Hong Kong Housing Authority, about the relationship between sustainable development and construction as long as the overall objective of the builder is an economically feasible, socially viable, and environmentally responsible final project. To make this possible, these three sustainability aspects should be examined in conjunction with three aspects of the infrastructure, 1- which is its function (products, goods and services), 2- how it does it (operations, procedures and practices), and 3- with what (natural resources required).

As a result of the importance that is being given today to the themes of climate change and environmental problems, recent research has focused on how sustainable construction practices can help to reverse the impacts of global warming (Wong and Qing, 2013). Research shows an increase in new development projects that seek sustainable certification, due to the awareness of the potential of green building to benefit the environment. For this, local governments have focused on encouraging sustainable development by means of rules and regulations, as well through permits and financial incentives, trying to bring the system to be the new way of construction (Robichaud and Anantatmula, 2011).

3.3.1 SUSTAINABLE BUILDING RATING SYSTEMS

With the boom of the design of sustainable buildings, in the last decades many countries have developed green buildings rating systems and environment assessment tools

(Fowler and Rauch, 2006). Assessment tools for green buildings were created by the Green Building Council of each country to attend the evolution of green building, but its use is not mandatory. Evaluations are performed by certified professionals (Zuo and Zhao, 2014). Sustainable building rating systems can facilitate the adoption of sustainability in construction projects, thanks to the fact they have a wider market, and can be included in the project objectives (Andreas et al., 2010).

Building Research Establishment's Environmental Assessment Method (BREEAM)

"BREEAM sets the standard for best practice in sustainable building design, construction and operation and has become one of the most comprehensive and widely recognised measures of a building's environmental performance. It encourages designers, clients and others to think about low carbon and low impact design, minimising the energy demands created by a building before considering energy efficiency and low carbon technologies" (BRE Global, 2015).

BREEAM 2011	
Environmental Section	**Max. Weighted % Points**
Land use & Ecology	10%
Water	6%
Energy	19%
Materials	12.50%
Health & Wellbeing	15%
Transport	8%
Waste	7.50%
Pollution	10%
Management	12%
Innovation (additional)	10%
Total	**110%**

Table 3.2:BREEAM weighting

Leadership in Energy and Environmental Design (LEED)

"LEED, or Leadership in Energy & Environmental Design, is a green building certification program that recognizes best-in-class building strategies and practices. To receive LEED certification, building projects satisfy prerequisites and earn points to achieve different levels of certification. Prerequisites and credits differ for each rating system, and teams choose the best fit for their project" (U.S. Green Building Council, 2015).

LEED 2009		
Environmental Category	**Weighting**	**Max. Points**
Sustainable Sites	23.60%	26
Water Efficiency	9.10%	10
Energy & Atmosphere	31.90%	35
Materials & Resources	12.70%	14
Indoor Environmental Quality	13.60%	15
Innovation in Design	5.50%	6
Regional Priority	3.60%	4
Total	**100%**	**110**

Table 3.3. LEED weighting

3.3.2 BENEFITS OF GREEN CONSTRUCTION

Benefits are identified from an environmental, social and economic view. In summary we be say that (Pitt et al., 2009):

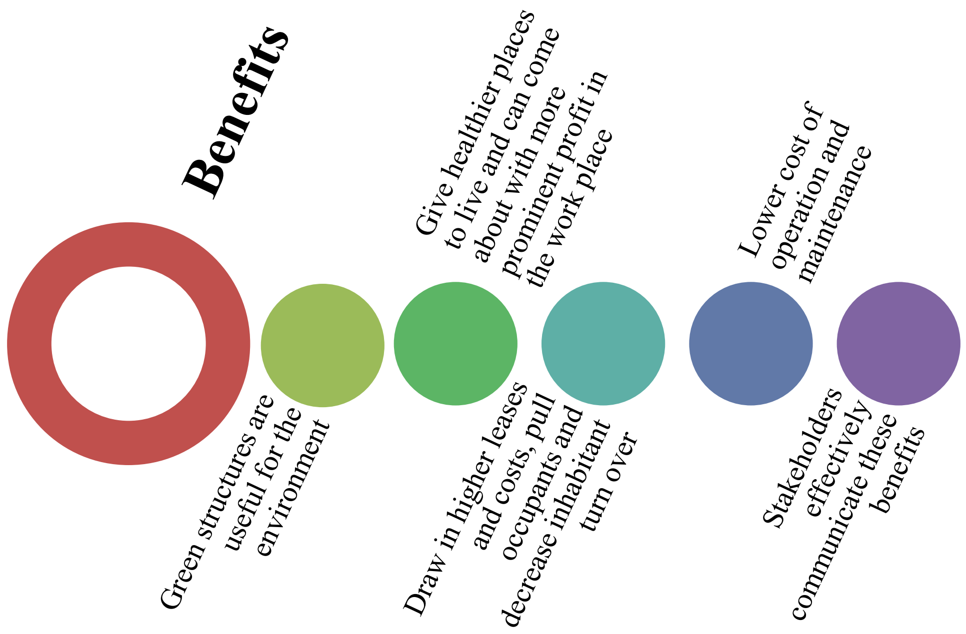


Figure 3.3: Benefits of green construction

3.4 CHALLENGES BARRIERS AND ISSUES FOR THE GREEN CONSTRUCTION

Regardless of the growth that has been presented, green building also has its problems and obstacles. The most usual is the high costs associated with being green. An investigation made by McGraw Hill Construction 2006, indicates that the perception of high investment delays the evolution of sustainable development, up becoming in the biggest restriction. A study in 2004 by Davis Langdon, found that cost variations between eco-friendly projects and traditional projects are widespread, but this initial investment can be recovered in long term reducing operational costs and maintenance. Is necessary for project managers to develop strategies to reduce or control costs during the initial phase, because the benefits of operational savings are not relevant to investors who are not interested in the other project phases (Robichaud and Anantatmula, 2011).

Green building must maintain the best features of the conventional system, and adapt with new mechanisms of productivity (Kibert, 2013). But it is not so easy to change from one mechanism to another; there are barriers that prevent the transition. The first is the implementation of green buildings and low return rate of Business. For Nigerian companies was discovered that the major impediments to the implementation of sustainable measures are the need for preparation of professionals and technicians, lack of tools, lack of legal regulation and lack of public awareness. It has been found that administration plays a key role in green building, since 50% of the obstacles is presented by the mistaken belief of the project managers that is a complicated transition process (Kasai and Jabbour, 2014).

Green building represents an increase from 2.7 to 9.3% in the total cost of construction, compared with the conventional method. Take about seven years to recover the investment, but it is expected that the time can be shorter with the reduction of resources by the design optimization, materials location and adaptability to existing conditions. The biggest problem is to create an awareness of savings in the population. This is because the target of the majority of investors is to earn money from constructions, making good cost management, regardless of whether the project is sustainable or not. The aim is not only to develop high technologies, is making buildings suitable for the weather (Li et al., 2014).

3.4.1 THE GREENING OF BIM

The construction industry should develop and adopt new methodologies for the design and construction of buildings in which the environment is less affected. Studies show that the demand for eco-friendly buildings has increased over time (Jrade and Jalaei, 2013). The different stages of development of a building (design, construction and operation) have been affected by the fundamentals of sustainability, especially energy consumption (Motawa and Carter, 2013). The benefits generated by sustainable buildings, also known as green, on the environment and human health, are recognized worldwide. Making a change towards sustainability implies a slight increase of 2% over the initial costs of a project, while savings received during the life cycle can reach 20% of the total project cost which represents their benefits is around 10 times higher than the initial costs. Hence, born the premise that sustainable buildings are more economically viable than conventional buildings (Azhar et al., 2011).

Over the years there have been methodologies and technologies for the decrease in CO2 emissions and energy savings targets to be achieved through sustainable design and efficient use of energy (Motawa and Carter, 2013). It has been identified he need that has the construction industry to create a frame design and construction which promotes economic sustainability by reducing cost overruns and time (Erezi et al., 2014).

For builders it be difficult to implement sustainable measures due to the following reasons: a) lack of information about sustainable materials and b) the lack of connection between the tools of analysis and design (Jrade and Jalaei, 2013). As well as the builders are interested in sustainable projects, BIM tools are positioning to become essential at the time of fully meet the proposed objectives in green buildings and is expected for the coming years to increase its use and scope (Wroblaski and Morton, 2010). Wong and Qing (2013) believe that research on the contributions that BIM offers to sustainable construction increases the potential of this new methodology, while contributing to sustainable development.

3.4.2 THE USE OF BIM ON GREEN PROJECTS

High performance facilities may be produced by the strategic combination of sustainable practices and the BIM technology, due to this latter has the potential to change traditional design practices (Azhar et al., 2010). It includes experimental analysis of structure, environmental controls, construction method, use of new materials, or systems and detailed analysis of user processes. In the field of building system analysis, it involves many functional aspects of the building system, such as structural integrity, ventilation, temperature control, circulation, lighting, energy distribution, and consumption (Jrade and Jalaei, 2013). Building Information Modelling represents new opportunities for sustainability and integrated design within the construction (Erezi et al., 2014).

Results of a survey conducted 145 companies in the United States dedicated to the design and construction indicate that practitioners of sustainable methodologies have realised the benefits in time savings and costs generated by the use of BIM, compared with traditional methodologies. The combination of sustainable strategies and BIM methodology has the ability to change traditional building practices and shed as a final product high performance facilities. (Azhar et al., 2011). BIM can create a model where the behaviour of the building can be assumed and can be taken measures for design to be incorporated throughout the design process. There are three main areas in sustainable design that are directly related to BIM, which are: the choice and use of materials, selection and management of the construction site, and systems analysis (Jrade and Jalaei, 2013).

BIM is considered as an essential factor to achieve the decrease of waste produced by industry, better use of energy and the diminution of negative effects to the environment (Wong and Qing, 2013). In the UK, the national regulation on energy performance and 'carbon' accounting needs to implement a methodology in the construction that can help to achieve the objectives of CO2 emissions. In order to get buildings of zero CO2 emissions, is essential to share the information produced by the behaviour of the building from its design to its occupation phase. For this it is required to create a supply chain between stakeholders, and is there where the implementation of BIM becomes practical (Motawa and Carter, 2013).

Among the major uses for which the BIM methodology is applied are to model energy usage, thermal flows, lighting patterns and other sustainability measures. The intelligent information created by the BIM model can conduct whole-building energy analysis, simulate performance, and visualize appearance. With that designers can obtain information which can improve the performance of the building throughout its life cycle (Motawa and Carter, 2013).

3.4.3 BENEFITS OF BIM FOR SUSTAINABLE CONSTRUCTION

Even though BIM still has a limited impact on green building, using several of its tools can be achieved sustainable results (Jrade and Jalaei, 2013). Within the digital database of BIM can be registered different attributes of the construction, such as carbon emissions, which facilitates sustainability assessments (Zhang et al., 2014).

The two principal advantages of the BIM application in Green Projects are integrated project delivery (IPD) and design optimization (Wong and Qing, 2013). Also, Krygiel and Nies (2008) consider that BIM positively affects the following sustainable aspects:

1. Building orientation: (To select the best building orientation that results in minimum energy costs).
2. Building massing: (To analyse building form and optimise building envelope).
3. Daylighting analysis: (To know the day light amount).
4. Energy Modelling: (To reduce energy needs and analyse renewable energy options such as solar energy).
5. Water harvesting: (To reduce water needs in a building).
6. Renewable energy: (To integrate renewable energy sources).
7. Sustainable materials: (To reduce material needs and to use recycled materials).

Building orientation

BIM simulations can be used to find the perfect orientation of the building, and calculate the rate of return on energy and feasibility of each system, to optimize the performance. Building orientation is about the position of the building in relation to the sun, and its impact on energy use and efficiency (Muzvimwe, 2014). Find the correct orientation of a building has the following advantages:

- Allows the greatest opportunity to use the natural daylight and less electric lighting systems.
- Allows for the most effective incorporation of electric lighting controls.
- Allows for less complicated eternal shading devices.
- Allows for integration of renewable energy systems like PV panels.

Building Information Modelling (BIM) is used to find the “Solar South”. To achieve the proper orientation of a building using environmental softwares of BIM, is necessary to add the objectives set for the orientation to the model (Krygiel and Nies, 2008).

Building massing

After the building orientation, building massing is one of the key factors for a healthy and sustainable building. Right massing allows building occupants have good access to daylight while still the building is optimal in thermal efficiency and comfort (Krygiel and Nies, 2008). Building massing is to manipulate the building the building form to determinate the comfort and efficiency of the building mass and systems, including quality, glazing, permeability, etc. by choosing the right mass for the building type and climate, the designer has a great chance to influence the energy needs of the building (Muzvimwe, 2014).

BIM for building massing is used to choose the optimal shape of the building. To make the comparison is necessary for each model have the same amount of occupiable space, the same number of users, the same operating schedule, and the same lighting and envelope systems. Another function is to analyse the building form to obtain a large reduction on energy use (Krygiel and Nies, 2008).

Daylighting

Daylighting allows good access to natural light for all the building occupants without compromising thermal efficiency and comfort. Natural is considered better than artificial light because gives to the occupants a sense and feel of connection to the outside (Muzvimwe, 2014). Daylighting can reduce the burdens of electric light, heat and energy. A high performance building to be successful must have a correct integration of solar energy into its design (Autodesk, 2005).

To perform the daylighting analysis with BIM tools is needed:

- The BIM model
- A daylighting simulation package, for geometry generation.

Nowadays, the most used softwares for daylighting are: Integrated environmental solutions virtual environment, Daysim, Autodesk´s 3ds ma (Krygiel and Nies, 2008), and Revit building (Autodesk, 2005).

Energy modelling

Energy modelling is the consideration of various factors that affect the energy use in a building, in order to predict the demands of energy of the building, and impact of the design in the global environment, also the ability to calculate real-time energy and water use levels (Muzvimwe, 2014). It is essential to apply a sophisticated energy analysis in a building design to achieve a reduction in energy consumption (Autodesk, 2005).

Energy performance calculations remain a challenge, but use of BIM technology could bring positive outcomes to that process (Muzvimwe, 2014). BIM for energy modelling is used to monitor the behaviour of the building, or to create assumed scenarios with which it seeks to match the design with the real performance of the building, and thereby maximize energy savings. BIM applications for energy analysis have been developed to improve this process but most of its use is in the design stage. Despite this there is a need for a methodology that can be suitably applied during the period of occupation, with which can be monitored the energy performance of buildings and ensure that energy objectives were achieved in practice (Motawa and Carter, 2013).

The main uses of BIM for Energy Optimization analysis were for lighting analysis, HVAC, and to facilitate obtaining a green building certification (Wroblaski and Morton, 2010).

Water harvesting

Most sustainable design is focused on achieving energy efficiency, however the water is a limited resource. Seventy percent of the Earth's surface is covered by water, but only one percent of this water is suitable for consumption, while population and demand for water continue to rise. Different mechanisms have been developed to solve the problems of water and meet the objectives of water conservation. For efficient water analysis should be collected the following parameters:

- The BIM model of the project,

- Internet to look up rainfall data from reliable, documented resources,
- A spreadsheet.

BIM helps to calculate how much rain water can be captured from the available roof areas and the expected water demand from sinks, toilets, water fountains, and another building fixtures (Krygiel and Nies, 2008).

Renewable energy

Renewable energy is naturally obtained steadily for energy flows occurring in the environment. It has many forms for application and is available worldwide and these resources are sustainable, if not generate CO2 emissions to the environment (Twidell and Weir, 2015). There are five main sources of renewable energy (U.S. Energy Information Administration, 2015):

- Solar energy from the sun, which can be turned into electricity and heat,
- Wind energy,
- Geothermal energy from heat inside the earth,
- Biomass from plants, which includes firewood from trees, ethanol from corn, and biodiesel from vegetable oil,
- Hydropower from hydroelectric turbines.

A BIM model can help to configure the building orientation, calculate the potential return in energy, and calculate the feasibility of each system. For this, must be selected correct source of energy for the project, depending on the location and availability of the resource to be used. BIM model allows to adjust and optimize the design of each system (Krygiel and Nies, 2008).

Sustainable materials

It is proven that in the construction is where most processed and raw material is used, therefore the environmental impact is significantly determined by the selected material (Zhang et al., 2014). When it comes to using BIM for sustainable buildings should be selected materials and processes with which their environmental impact can be evaluated easily (Jrade and Jalaei, 2013). There are numerous material guides, certification systems, and selection methodologies available to help building professionals collect information, create databases and reduce the quantity of material needed on a project. To create this database usually are used three kinds of materials:

reclaimed or salvaged materials, recycled materials o materials with a recycled content, and locally produced materials (Krygiel and Nies, 2008).

3.4.4 BIM AND WASTE MANAGEMENT

It is estimated that the annual production volume of waste in the construction industry is:

a) 164 million tonnes in the US,
b) 70 million tonnes in the United Kingdom,
c) And over 16.5 million tonnes in Australia.

Despite the fact that the data are representative of only three countries, these figures show that the amount of waste of a country is directly proportional to the size of its construction industry (Erezi et al., 2014). The quantification of waste generated in construction and demolition are essential for effective management of solid waste. Results from these estimates provide data facilitating to project managers predict the real size of the waste, and thus make the right decision to minimize environmental impact and implement sustainable management (Cheng and Ma, 2013).

Good use of BIM in making design decisions for the reduction of waste, positively affect the project in terms of economic sustainability (Erezi et al., 2014).

3.5 CURRENT PROBLEMS IN USING BIM FOR SUSTAINABILITY

In spite of that BIM proves to be practical, problems still exist for its use on Green projects. An example of this is the application of BIM for energy analysis. Nowadays, this process is based on the estimation of values of loads, air flows and heat transfer for the simulation, which may give few reliable results. Another problem encountered is the management of data between BIM and energy analysis tools. Although BIM data can be exported easily to energy analysis tools through IFC and gbXML schema, this model has the difficulty that in some cases is necessary to modify the construction models to obtain better buildings performance. Manual configuration is necessary in these cases, therefore is necessary further development of BIM to make it more applicable in the area of sustainability (Motawa and Carter, 2013).

To obtain optimum results of BIM in sustainable projects, it turns out to be essential to make changes in some aspects. These include the drivers, actions, good practices, impacts and benefits of sustainability analysis integration in the BIM-collaborative processes on one hand, and the barriers, limitations and deficiencies of current practice on the other. All the factors mentioned above must be considered when designing high performance projects with sustainable fundamentals. It is not an easy task because in some cases there may be conflicts between them, implying an objective viewpoint from the earliest stages of design. But thanks to BIM combines a wide range of software for measuring sustainable performance is possible to manage information throughout the lifecycle of a project (Zanni et al., 2013).

3.6 TRIGGERS, DRIVERS AND BARRIERS FOR CURRENT AND FUTURE USE OF BIM ON GREEN PROJECTS

According to the results of studies conducted by McGraw-Hill, Green BIM practitioners believe that the construction industry is just beginning to reap the benefits that BIM provides to achieve green goals. The answers provided show that only 17% of the construction industry generally acknowledge that BIM provides the potential to meet the Green buildings objectives. Practitioners also believe that an increase in green construction practices, can motivate more developers to adopt BIM in their projects.

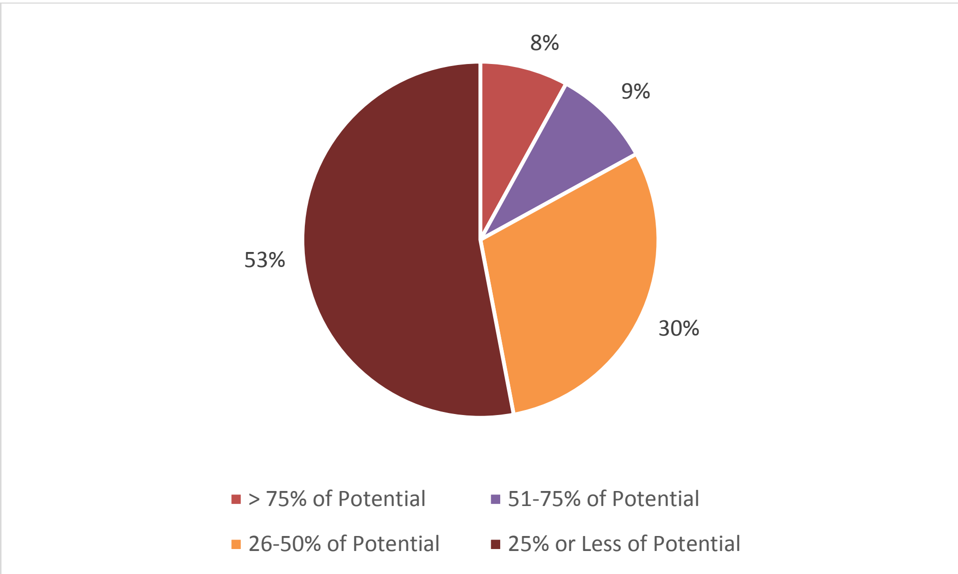


Figure 3.4. BIM's potential to achieve Green Objectives

Source: SmartMarket Report: Green BIM (McGraw-Hill Construction, 2010)

Companies that spend more than 75% of their projects to green practices, feel that every day there are more possibilities of using BIM to achieve green goals. These results reflect the similarities between firms that are new and which are old in the implementation of BIM, and Green construction, that more green buildings will contribute to the adoption of BIM.

3.6.1 THE FUTURE OF GREEN BIM ADOPTION

It is expected that 78% of companies that do not implement BIM in Green Projects do so in a period of about three years, which represents an extraordinary growth in short term. Contractors are highly likely to be the new Green BIM practitioners, which demonstrates that the market recognizes the potential that owns Green BIM to improve design and construction, only that this demand is repressed

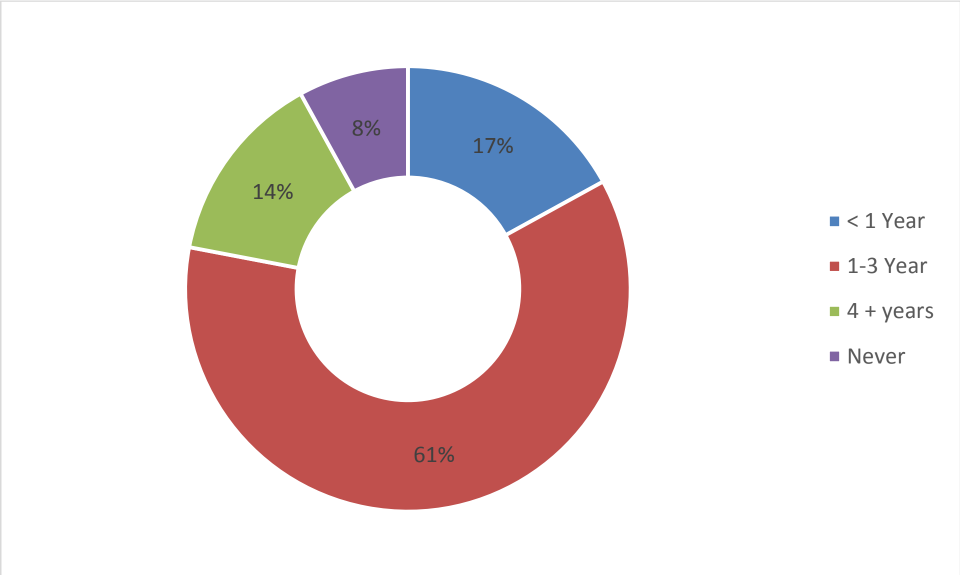


Figure 3.5. Timing expected to Green BIM market penetration

Source: SmartMarket Report: Green BIM (McGraw-Hill Construction, 2010)

3.6.2 TRIGGERS AND DRIVERS FOR FUTURE USE OF BIM ON GREEN PROJECTS

The most important driver in using BIM on Green projects, according to Non-Green BIM companies are clients. The 36% of survey respondents believe that the main reason for the future growth of Green BIM is the customer demand. The 28% of survey respondents agree that the next driver in importance is the differentiation between Green BIM and conventional methodologies. It is not a coincidence that the most important triggers for the increased of Green BIM use are clients, thanks to the 55% of the Non-Green BIM practitioners are contractors.

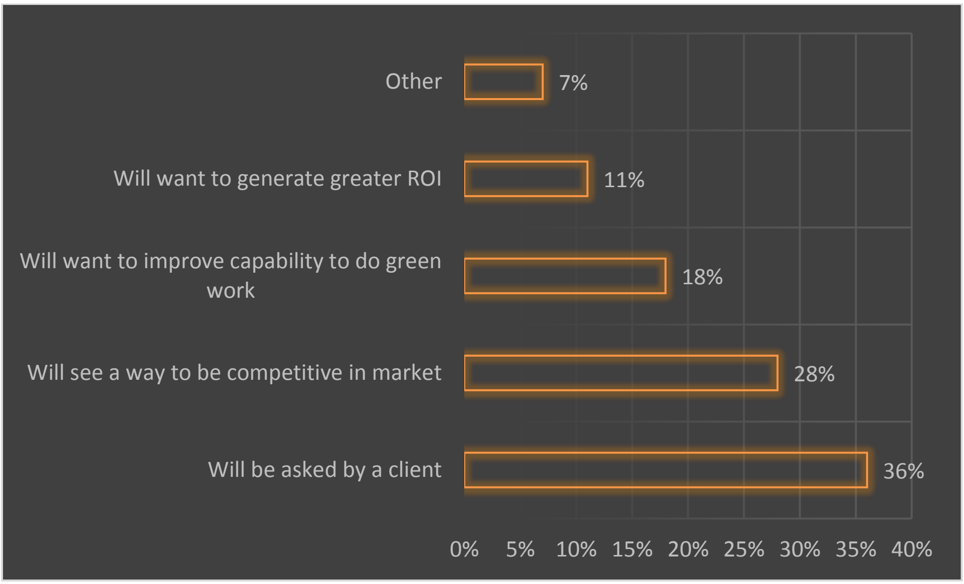


Figure 3.6. Triggers to use of BIM for Green projects

Source: SmartMarket Report: Green BIM (McGraw-Hill Construction, 2010)

In order to can be possible the above mentioned, the project owners should be educated about the benefits that BIM provides to conventional projects, but especially in sustainable projects. Another important factor is to develop tools with which the owner see the performance of the construction, and thereby increase the interest.

The requirements of Green Building rating systems will handle the interest of owners toward tools and methodologies to measure and improve the buildings performance. The market is another factor that can become an important driver due to the demands of low carbon emissions to the environment.

3.6.3 USE OF BIM ON GREEN PROJECTS

Companies implementing Green BIM give greater use of BIM in new green building projects.

The fact that companies implement BIM more occasionally for green renovations that minor green modifications, shows the perception that BIM is more applicable to green and complicated projects. The global economic crisis has impacted most heavily on large projects that small projects. This has led to the sustainable refurbishment and modernization of existing projects. Therefore, growth of the BIM will be because both applicable to minor retrofits. In the case of Operations and Maintenance, the results are because most companies are only involved in the phases of design and construction.

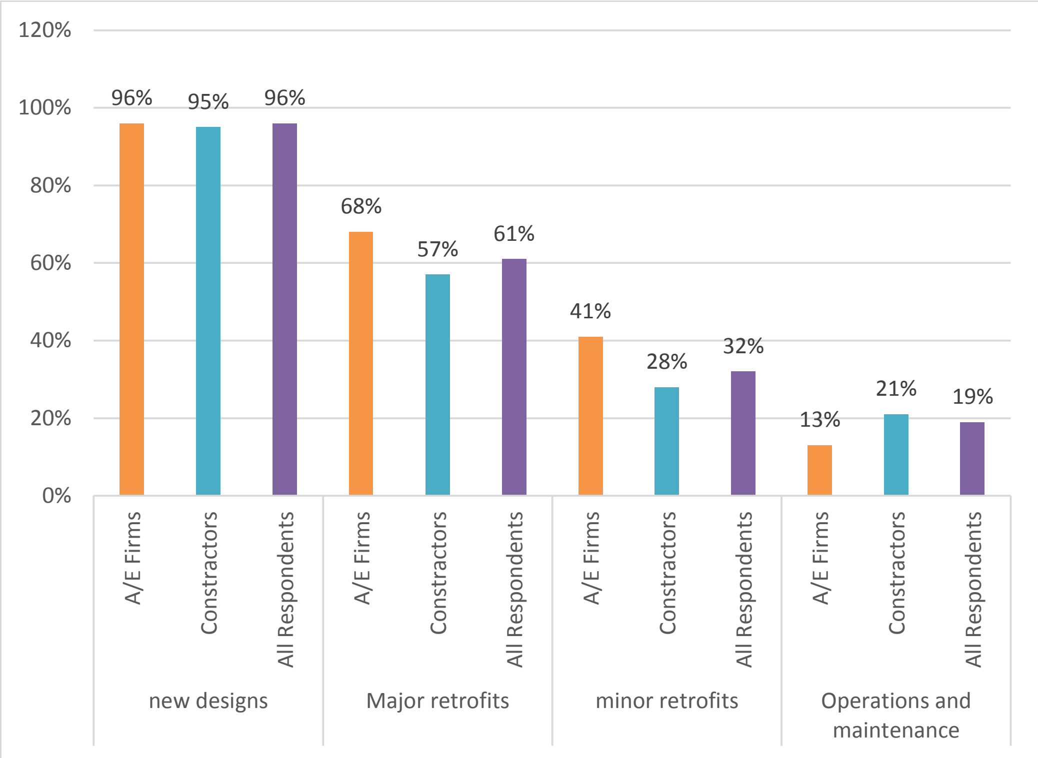


Figure 3.7. Green BIM project types for Green BIM practitioners

Source: SmartMarket Report: Green BIM (McGraw-Hill Construction, 2010)

3.6.4 GREEN BIM IMPLEMENTATION DRIVERS

The owner is the main driver for contractors to start implementing BIM on Green projects, while for A / E firms is increasingly important how BIM contributes to accomplish their sustainable goals. The 56% of drivers for contractors was the owner's requirements, even though this factor affects only 32% of design firms.

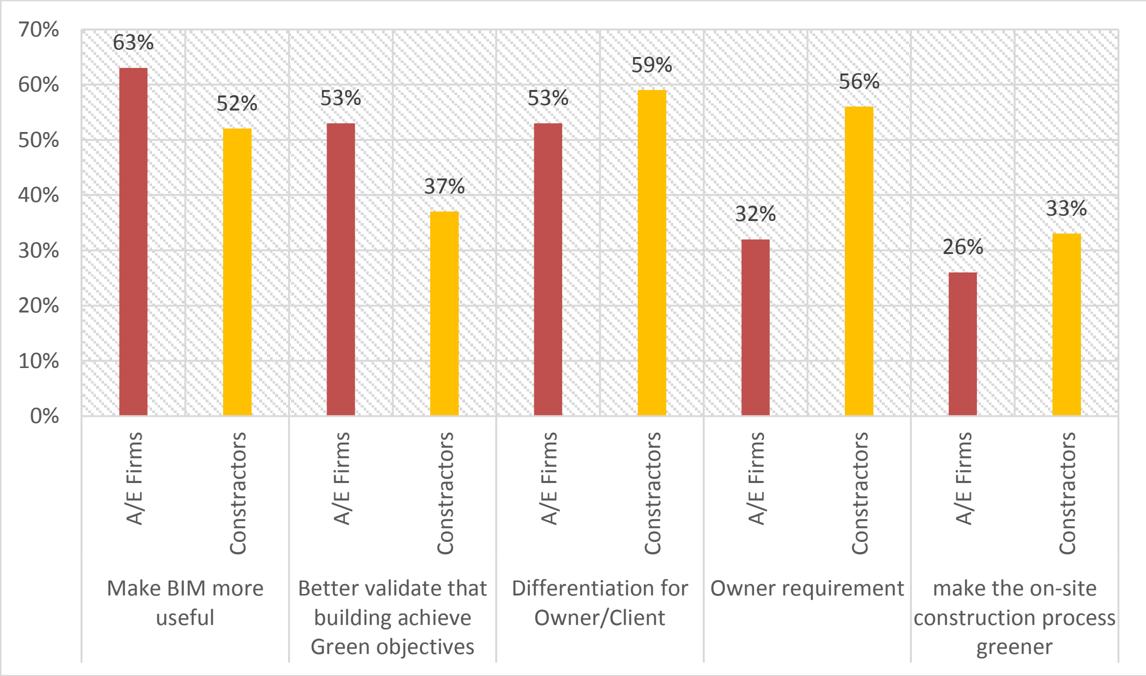


Figure 3.8. Green BIM implementation drivers

Source: SmartMarket Report: Green BIM (McGraw-Hill Construction, 2010)

3.6.5 GREEN BIM ADOPTION DRIVERS

Project developers, design firms both as contractors, suggested that the principle drivers for the adoption of BIM on green projects are owner demand (85%) and saving time and money (76%). One factor that can be considered potentially important is the demand created by design firms. A / E firms are and will be an important driver for the full adoption of BIM. Over 50% of respondents recognize the importance of those in the initial promotion of Green BIM.

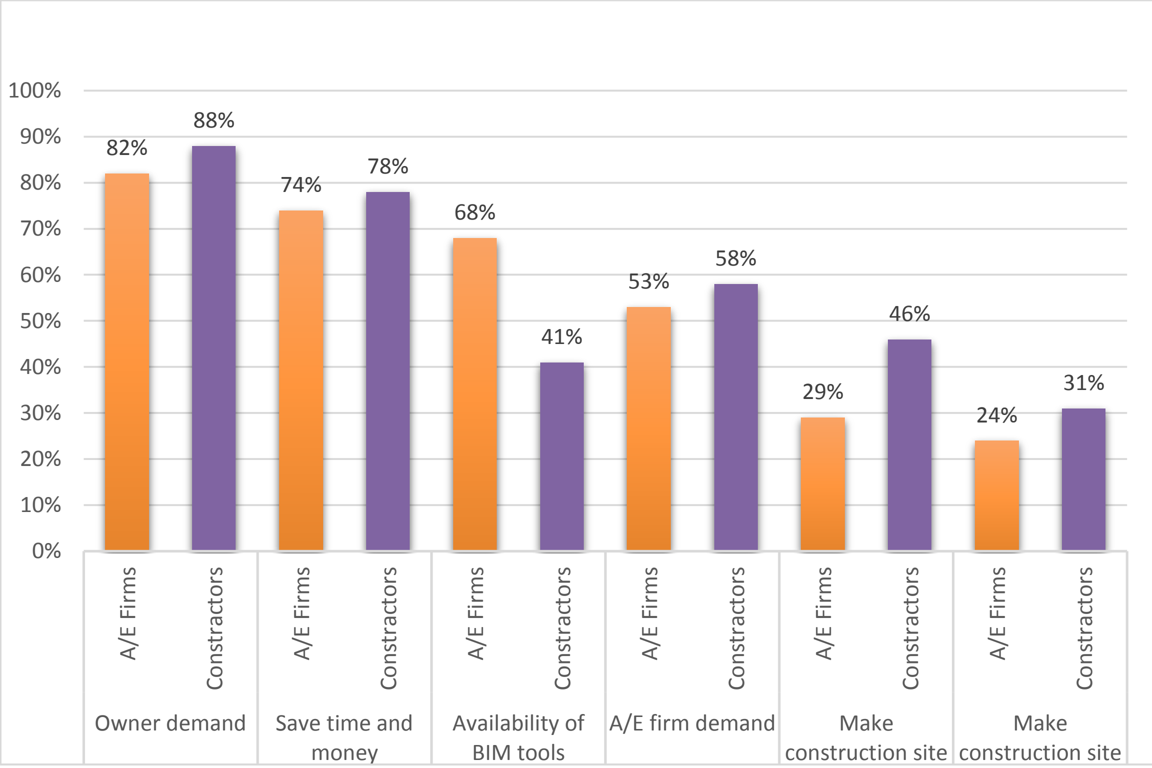


Figure 3.9. Green BIM adoption drivers

Source: SmartMarket Report: Green BIM (McGraw-Hill Construction, 2010)

3.6.6 BARRIERS FOR USING BIM ON GREEN PROJECTS

The belief that conventional tools are easy to use and compelling nature of these tools are the main obstacles to the adoption of Green BIM. However, as BIM tools are adapted to meet the needs of sustainable projects, the implementation of this technology forward with more speed in the coming years.

Other factors are directly influencing the lack of direct customer demand, and fewer green projects in their current pipeline.

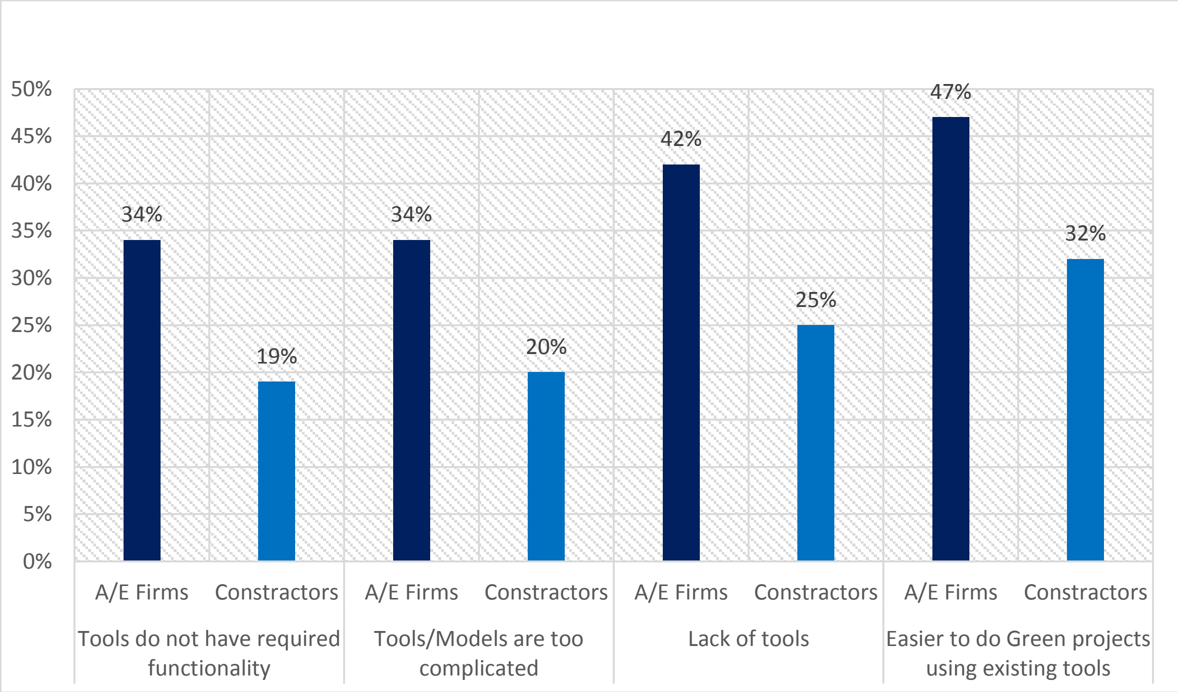


Figure 3.10. Factors behind not using BIM for Green projects

Source: SmartMarket Report: Green BIM (McGraw-Hill Construction, 2010)

3.7 MOBILE TECHNOLOGY AND CLOUD COMPUTING

The investigation of computer-based technologies has become the main topic for researchers in the construction industry Froese (2009), and several studies have been done (Saidi, *et al.*, 2002; Wang, *et al*, 2007, Löfgren, 2007) that look at different forms of technology and their application to construction management. Cloud computing is an example of an uprising technology that is believed to significantly help the construction industry. Nazri and Ibrahim (2013) discuss the benefits that the implementation of cloud computing brings, like freeing company resources and considerably reducing IT costs. Nevertheless, security and intellectual property issues have prevented some major companies from migrating to cloud computing services (Beach, *et al*, 2013).

Anumba and Wang (2012) identified three main limitations of traditional management of information in construction projects, these are:

- Centralized Model. In case this model fails, information could be lost completely.

- Centrally Managed Data. Impairs the ability for the use of different data models.
- Unwillingness from project participants to publish data. This could be due to trust issues on IT security.

All this limitations are believed to be solved by the implementation of cloud computing. Cloud computing can allow project members to use different formats of documents that are supported by the cloud portal and be visible by all participants, also, the cloud being a software service, is not a one centralized hardware system that has the risk of suffering system failure or loss of data.

The potential benefits of cloud computing for the construction industry is presented by Gens (2009) and concludes that the principal benefits of cloud computing perceived by construction professionals are: Paying only for what is used, easiness and rapidness of deployment to end users, monthly basis form of payment, encouragement of standard systems, less requirement of IT staff and simpler sharing of data along partners.

Part of the development the Information Technology (IT) industry has experience in the last decade is the integration between platforms, which allows for faster exchange of data (Leung, *et al*, 2013). Mobile technology has found an ally in cloud computing for the management of large flows of data, that way the mobile applications process the information and this is ultimately stored in the cloud. Although this is a very popular topic in recent investigations, research on mobile technology and cloud computing for the construction industry has mainly focused on the application it has on project management and not in specific construction processes and activities.

3.8 SUMMARY

This chapter has provided an overview of the current situation of the topic studied. In the first part of the chapter is offered a general introduction to the most important aspects of Building Information Modelling, green construction and mobile technology and cloud computing. It was presented the industry sustainable projects construction in general, and how BIM is applied to make this sector more efficient. The general criteria for both fields were presented, as well as benefits and barriers that are necessary for face its implementation, which seeks to propose general solutions to the end of the investigation.

CHAPTER 4 : THE RESEARCH METHODOLOGY

4.1 INTRODUCTION

This chapter outlines the research methodology and describes the various steps of the research process. The research aims to explore how the UAE construction organisations are managing sustainability strategies for improving their competitiveness. There is the description of the research methods, the data collection process and the evaluation that were part of the thesis.

4.2 OVERVIEW OF THE RESEARCH PROCESS

According to Greenfield (2002) research is defined as "an art aided by skills of inquiry, experimental design, data collection, measurement and analysis, by interpretation and by presentation". The main reason to promote a research is to acquire new information and relevant data towards a specific subject. Davies and Hughes (2014) explain how research promotes a systematical, logical and organised way to understand the information obtained about a certain topic. It is also stated how different methods of research have been developed in order to meet the different needs exist when investigating a specific subject. The different methods are used as the procedure for the correct collection and analysis of data.

The research method chosen for a specific investigation is driven by the philosophies that the researcher has towards the investigation. Punch (2013) describes philosophy as the study of the fundamental nature of knowledge, reality and existence. Based on this it can be seen how the philosophy of a research is an image of the importance given to the investigation by the researcher and at the same time will drive what approach is used to obtain information on how to present it.

In this research, the research process is identified into three key phases within its flexible boundaries. The three phases are the literature review, research strategy and the output. The development of the research work started with the literature review (i.e. Phase 1). Literature review is defined as "a systematic, explicit and reproducible method for identifying, evaluating and interpreting the existing body of recorded work produced by researchers, scholars and practitioners (Naoum, 2013). Additionally, the literature review helps to delimit the research problem or the context of the topic; by recognising what have been done, and finding the gaps in knowledge to outline what needs to be done, it also helps to avoid fruitless approaches, and gain the main research methodologies and insights utilised in similar or related studies to the research topic area.

For the purpose of this study, an extensive and critical review of literature was conducted at the initial stage of the research and during the research process to establish a solid theoretical base for the study area and a basis for addressing the problems and attaining the study objectives. The literature review conducted in this research covered the subject of sustainability in the construction sector, Green BIM strategies and Mobile Application technologies its applicability within construction industry. Additionally, reflected the associated issues, drivers, benefits, barriers and challenges to successful implementation. Furthermore, undertaking the literature review provided the critical analysis of numerous sustainability strategies adopted in the construction industry, that helped in selecting the most appropriate approach for assessing the benefits of the sustainability strategies in the UAE construction industry.

The sources of literature for this study included journal articles, reports, books, and conference proceedings. The first stage of the reviewing the literature was to find peer reviewed papers that contained the word construction and sustainability or in the title or abstract. This helped to outline and identify a list of authors active and concerned in the area, journals that covered related articles, papers quoted in or referred to these articles. Based on this, further searches were made, using various electronic databases including; Elsevier (Science Direct and SCOPUS), ProQuest, EBSCO, Web of Knowledge, and internet search engines (Google Scholar), and the university library catalogue. During the different research process stages, the practice of reviewing the literature was repeated at intervals.

Phase 2 of the research process is the research strategy. The study features a qualitative data collection and analysis techniques. A review of literature was conducted at each stage of Phase 2 to enable a better understanding of the subject matter of the study.

Phase 3 discusses research outputs. It constitutes results analysed in chapter 5, chapter 6, chapter 7, chapter 8, and chapter 9. A framework for managing sustainability strategies in the UAE construction organisations is discussed in the penultimate chapter 10 of this thesis. The aforementioned chapters are substantiated with relevant literature.

4.3 RESEARCH DESIGN

Research Design is defined as the process of discovering something; it should be a reasoned process performed scrupulously, with rigor and with careful weighing of evidence and arguments (Hughes and Sharrock, 1997). Design of research methodology is a crucial and difficult step in the research process (Akintoye *et al.*, 2007). Methodology is the overall approach to the research process, from the theoretical underpinnings to the collection and analysis of data (Hussey and Collis, 2003). It needs to encompass the rationale and philosophical assumptions that underlie this research, which in turn influenced the methods that are used to investigate the research aim and objectives and to collect, analyse and interpret data. It is key to have a robust methodology to be able to satisfy the aim and research questions of this investigation.

Distinctions exist between quantitative and qualitative researchers with respect to ontology, epistemology, axiology, rhetoric, logic, generalisations and cause linkages (Onwuehbuzie and Leech, 2005). In other words, issues have raged in social sciences regarding the superiority between the major paradigms; the positivist approach and the constructivist orientation. In addition, to this issues have arisen with regards to the idea of incommensurability and incompatibility; whether quantitative and qualitative approaches should be used in the same study (Molina Azorin and Cameron, 2010).

Clearly, there are different epistemological and ontological assumptions that underpin different methods and paradigms. According to Howe (1988) the constructivist paradigm is more related to qualitative methods, whilst the positivist paradigm underlies quantitative methods. The organising idea of a continuum may be used in order to identify the main epistemological and ontological assumptions.

Positivism is based on acceptance as fact that the world around us is real and that it is possible to find out about these realities. Knowledge is derived using scientific method and based on sensory experience, with the aim at developing a unique and elegant description of any chosen aspect of the world that is true regardless of what individuals think. Through development of these facts, knowledge is built up in a cumulative fashion, despite some false starts (Walliman, 2011, p.21).

Alternatively, constructivism is based on the philosophical doctrines of idealism and humanism, maintaining the view of the world around us is the creation of the mind. This means that we can only experience it personally through our perceptions, which are influenced by our preconceptions, beliefs and values. Observation of a phenomena is not from outside the system, instead the researcher is inextricably bound into the situation under study. Indeed, there can be more than one perspective and interpretation of a phenomenon (Walliman, 2011).

In short, constructionism has relativist ontology, with epistemologically, the achievement of objectivity being rejected and emphasis placed on individual understanding particular viewpoints (Molina Azorin and Cameron, 2010). On the other hand, a hard positivism ontology asserts an objective reality is out there to be found and epistemologically accomplished with knowable degrees of certainty using objectively correct scientific methods (Long *et al*., 2000).

According to Powell (2001) pragmatists neither agree with positivists in that demands of a research cannot be fully satisfied by a theory, nor with constructivists in that demands of a research can be satisfied by almost any theory. Consequently, allows the usage of any, or a mix of multiple methods, approaches, choices and techniques as long as they help to answer the research questions (Saunders *et al*., 2009).

Saunders *et al*. (2009) expressed that under the pragmatism ideology the most important determinant of the epistemology, ontology and axiology adopted is the research question. Indeed, there are various forms of pragmatism and for many forms knowledge claims arise out of actions, situations and consequences rather than antecedent conditions. In addition, Creswell (2003) expressed that instead of methods being important, the problem is of most importance. In the same way, Saunders and Paul (2013) point out that pragmatists are more concerned with practical consequences of research findings, thus by believe that one standpoint can never be suitable for answering all types of research questions. The philosophical underpinning of this research was based on positivism pragmatism as it is the underpinning of qualitative method of study.

4.4 RATIONALE FOR CHOOSING QUALITATIVE METHODOLOGY

Adopting a qualitative approach in obtaining research would involve a small number of in depth responses through interviews whereas a quantitative approach would involve a large spread of participants in the form of questionnaires. Utilising a qualitative approach would provide deeper level of insight which is ideal for area where there is sparse knowledge available (Liamputtong and Ezzy, 2005). Also regarding the nature of the topic there is particularly the concern of participants providing socially pleasing answers which is a criticism found among large scale quantitative studies along with low response rates to the questionnaires (Collis and Hussey, 2003). The Table 4.1 below details the range of definitions and interpretations present on qualitative research.

Majority of the quotes from the Table 4.1 detail how qualitative research is an interpretive, based upon the researchers subjective opinions. These are concerns over utilising a qualitative methodology, based upon lacking scientific rigour (Mays and Pope, 1995). This is due to the nature of qualitative research being subjective and exploratory it lacks the definitive precision obtained from a quantitative method limiting the forms of analysis available. This is demonstrated by Mays and Pope (1995) where it is highlighted qualitative research "is merely an assembly of anecdote and personal impressions". Due to the personal nature of the data obtained from qualitative research it could provide notable inequalities in the data obtained. This is shown in in the following quote "there is no guarantee that a different researcher would not come to radically different conclusions" (Mays and Pope, 1995). Researcher bias is also another key concern to monitor when undertaking a qualitative study. It is unlikely that a topic would be approached without some pre-understanding which is likely itself to be unconscious, making it difficult to identify and address (Walsh, 1996).

Table 4.1: Range of definitions and interpretations present on qualitative research

Quote	**Source**
"Qualitative researchers are interested in understanding the meaning people have constructed, that is how people make sense of their world and the experiences they have in the world"	Merriam (2009)
"(Qualitative research is) research using methods such as participant observation or case studies which result in narrative, descriptive account of setting or practice. Sociologists using these methods typically reject positivism and adopt a form of interpretive sociology"	Parkinson and Drislane (2011)
"Qualitative research is situated activity that locates the observer in the world. It consists of a set of interpretive, material practices that make the world visible. "	Denzin and Lincoln (2005)
"Qualitative research involves any research that uses data that do not indicate ordinal values"	Nkwi, et al., (2001)

Regardless of any shortcomings or criticism of qualitative data analysis it remains to be most effective method given the nature of the study. This is due to both sustainability and competitive advantage being two abstract concepts not definitive terms with clear and precise meaning. Although as demonstrated in the literature review the two terms correlation between the two terms is increased under a more specific understanding but this doesn't mean that the terms remain subjective and open to a number of different interpretations. This illustrates why a deeper level of insight is required where statistical representations are unlikely to provide greater understanding of experiences and views of UAE construction professionals.

Table 4.2: Strengths and weaknesses of qualitative research

Strengths • The data are based on the participants' own categories of meaning. • It is useful for studying a limited number of cases in depth. • It is useful for describing complex phenomena. • Provides individual case information. • Can conduct cross-case comparisons and analysis. • Provides understanding and description of people's personal experiences of phenomena. • Can describe, in rich detail, phenomena as they are situated and embedded in local contexts. • The researcher identifies contextual and setting factors as they relate to the phenomenon of interest. • The researcher identifies contextual and setting factors as they relate to the phenomenon of interest. • The research can study dynamic processes. • The research can use the primarily qualitative methods of grounded theory to generate inductively a tentative but explanatory theory about a phenomenon. • Can determine how participants interpret constructs. • Data are usually collected in naturalistic settings in qualitative research.	• Qualitative approaches are responsive to local situations, conditions and stakeholders' needs. • Qualitative researchers are responsive to changes that occur during the conduct of a study and may shift the focus of their studies as a result. • Qualitative data in the words and categories of participants lead themselves to exploring how and why phenomena occur. • One can use an important case to demonstrate vividly a phenomenon to the readers of a report. • Determine idiographic causation. **Weaknesses** • Knowledge produced may not generalise to other people or other settings. • It is difficult to make quantitative predictions. • It is more difficult to test hypotheses and theories. • It may have a lower credibility with some administrators and commissioners of programs. • It generally takes more time to collect the data when compared to quantitative research. • Data analysis is often time consuming. • The results are more easily influenced by the researcher's personal biases and idiosyncrasies.

Source: *Johnson and Onwuegbuzie (2004).*

Amaratunga *et al*. (2002) noted that there are three claims for the power of qualitative data, which is discovery, exploration of a new area and developing hypotheses. In addition, to these claims a research needs to know both sides of the coin in order to fully understand and utilise the approach as can been seen in Table 4.2.

Qualitative research is exploratory in nature working towards building foundations in a particular field of study by seeking understanding (Tetnowski and Damico, 1999) whereas quantitative research seeks to measure something. This matches with the definition provided by Nkiwi, et al., (2001) stating that qualitative research is for when there is a lack of ordinal values. Ultimately choosing the methodology in this circumstance surpasses just simply looking towards the advantages and disadvantages of each method but which option provides the best data for the purpose of the study. Considering that qualitative research provides data that is explanatory and is also allows for interviews which allow for a greater involvement from the researcher, resulting in greater response rate and quality of answers.

4.5 DATA COLLECTION

Concluding that the qualitative approach is a superior method of obtaining data in regards to the given topic, it is crucial to designate a method within the spectrum of qualitative research methods. The most suitable method is to use semi-structured interview on an in-depth individual level, the alternative of unstructured interview is not compatible with this field of research. Another research method which is unsuitable is group interviews as it will result in a number of inconveniences and inconsistencies within the data. First there is the problem of arranging a number of professional within the UAE construction industry to conduct the interview at the same time, which will be difficult due to each person having belonging from different organisations each belonging to a busy work environment. Second there may be greater motivation of participants wanted to give more socially acceptable answers. Group interviews are suited towards a discussion or debate type situation where reasonable understanding of how the topic relates to the participants can be determined, there is also the danger of the interview leading off onto tangents which requires a skilled interviewer to keep the interview focused. Semi structured interviews are ideal for this method of research as this allows to delve into the subject matter in a manner where aspects in the conversation can be developed in contrast to group interviews which are focused towards multiple participants speaking on the same issue.

Semi-structured interviews were chosen as the data collection method because they have the potential to generate rich data to explore a range of perspectives and develop a holistic viewpoint (Cassell and Symon, 1994). Interviews were recorded and transcribed. Interviews covered topics such as details of the business; concept of sustainability, key drivers for implementing sustainability strategies; key sustainability strategies implemented; key challenges for implementing sustainability strategies, green BIM and mobile application strategies related to UAE construction organisations.

4.6 SAMPLING FRAME

Forza (2002) stressed that before discussing a sample the following terms need to be defined population, population element, population frame, sample, subject and sampling. Population refers to the entire group of individual and firms, with an element being a single member of the population. The population frame is a list containing all of the elements in the population from which the sample is to be drawn; a sample is a subset of the population, comprising of some members selected from the population. Sampling is the process of selecting the sufficient number of elements from the population so that by studying the sample and understanding the characteristics or properties of the subjects, the researcher will be able to generalise these to the population elements. Indeed, collecting data is difficult from the entire population and sampling helps overcome these difficulties.

According to Abowitz and Toole (2010) with regards to a sampling plan, there are two initial questions: the type of sample or sampling procedure used and the sample size. Indeed, typically good science involves probability based sampling in order to minimise the chance of bias within the data. Despite this, probability based methods are rarely feasible in applied settings as in the construction field and may not yield a reasonable response rate. This is why convenience samples are so common within construction research.

Furthermore, research based on non-probability sampling techniques such as that using convenience samples, may provide useful insights but are limited with regard to the accuracy of estimates and its generalisability to larger populations. In other words, with non-probability based samples in particular it is harder to estimate the size of the sampling error nor determine what if any, sample bias exists in the data (Abowitz and Toole, 2010).

The sampling technique used in this study was convenience sampling. Black (2010) expressed that elements for the sample are selected for the convenience of the researcher, hence the researcher typically chooses target respondents who are readily available. However, Bajpai (2010) stresses that this convenience approach eliminated the chance factor in the sampling selection process and thus suffers from non-randomness.

For this study, participants were selected from the top 100 large Architecture, Construction and Engineering consultancy practices across the UAE. Each of the individuals chosen were contacted by e-mail requesting if they were willing to partake in the study. All the interviews was conducted face to face where in a face to face interview there is much more information which can be attained, besides from the actual vocal response towards the questions from social calls such as body language (Opdenakker, 2006). However in this circumstance the emphasis isn't towards the interviewee's personal emotions but rather their expert knowledge and industry experience which is unlikely to evoke a response where social calls would need to be analysed. Also the problem with face to face interviews is it requires a great deal of time and money to be expended through travelling to the destination, there could be the possibility of the interviewee being unavailable due to unforeseen circumstances (Opdenakker, 2006).

The study sample included directors, advisers and managers responsible for sustainability strategies implementation in their respective organisations, as presented in Appendix B. The participants were grouped by their job title: directors, advisors and managers. All the interviewees have considerable experience in the UAE construction sector; in particular they had relevant experience on sustainability issues, with some of them having 'sustainability management' in their job titles.

4.7 DATA SATURATION

An important sample size issue in qualitative research involves saturation of information (Strauss and Corbin, 1998). According to Renukappa and Egbu (2012) saturation is a term used to describe the point when no new insights or range of ideas are generated through adding more data. Creswell (2009) pointed out that a theoretical sampling process usually involves 20-30 interviews before data is saturated. However, Aspinall *et al*. (2012) in their study only interviewed 7 participants and still stated this amount was acceptable due to the fact that qualitative research stresses in-depth investigation where the emphasis is on quality rather than quantity. In other words, their objective was not to maximise numbers but to become saturated with information upon their topic.

In this study, data were collected until no new aspects of the sustainability related strategies were revealed. In this study, actual saturation of data occurred before the 41 interview. Therefore, to ensure greater dependability and transferability (Creswell, 2014), a total of 44 professionals from 32 organisations were interviewed.

In this study, the interviews lasted between 40 and 90 minutes. The format of these interviews was face-to-face, and the transcripts were recorded and supplemented with field notes as appropriate. These interviews were recorded with permission and supplemented with field notes. During interviews, visible evidence of sustainability activities in the interviewed organisations (e.g. posters, awards) was also noted.

Full, verbatim transcripts were produced to ensure nothing was omitted based on subjective filtering by the researcher. Audio tapes were frequently replayed to pick up additional data from voice inflection and demeanour, laughter and joviality, and other nuanced behaviour otherwise lost during transcription.

4.8 DATA MANAGEMENT

Blismas and Dainty (2003) made a number of significant points with regards to the use of software packages for data management which are acknowledged: the restriction of the study imposed by a software; importance of understanding how the software package operates and what the weaknesses are so these can be addressed; to remember that the computer is only to aid the process; advantage of a software package is that all the data is contained 'within a single analytical environment'; a lot of work is required on the part of the researcher despite use of a software package; and importance of making any prejudices of the researcher apparent in the research explanation.

Furthermore, in a comprehensive assessment by Morison and Moir (1998) on the pros and cons of using software for coding, limitations seemed to outweigh benefits. When purported efficiency of data management and retrieval capabilities were weighed against the potential loss of 'familiarity with the data engendered through repeated handling, reading and re-reading that is part of the analytical process itself distancing researcher from the data through mediation of computer software'. Therefore, it was decided that a better approach was to use paper, pen and the capabilities of Microsoft Word.

4.9 ETHICAL ISSUES

Since the nature of qualitative data is based on interaction between researcher and the participants, it can be challenging throughout the different stages of study. By considering qualitative data collection in a research there are some ethical challenges to be taken into account. Qualitative data collected can be described as interpretive research where this method investigating *why* and *how* of a human being and the findings may be controversial if the interpretation is incorrect and bias. Therefore, ethical guidelines was been implemented in order to deal with ethical challenges of qualitative studies. The first stage is the ethical form submission to get approval from the University of Wolverhampton for this research. As far of the ethical form concern, it has been approved to proceed to the next level of the research study. The participant given information on the ethical guidelines as the relationship and the intimacy during the research, treated as “private and confidential”. The participant has been informed of the control and ownership of the data belongs to the researcher on the purpose of study.

4.10 DATA ANALYSIS

As part of the analysis of the interviews, content analysis was employed. The past two decades have seen an increasing scholarly interest in qualitative methodologies to study complex business phenomena, borrowing and adapting from more established disciplines (Miles and Huberman, 1994). The content analysis began as a tool for quantitative researchers, now it is increasingly being used in qualitative studies (Silverman, 2004). Content analysis, a class of methods at the intersection of the qualitative and quantitative traditions, is promising for rigorous exploration of many important but difficult-to-study issues of interest to management researchers (Morris, 1994).

Weber (1990) defined content analysis as “a research method that uses a set of procedures to make valid inferences from text”. The key assumption is that the analysis of texts lets the researcher understand other people’s cognitive schemas (Huff, 1990). At its most basic, word frequency has been considered to be an indicator of cognitive centrality or importance (Huff, 1990). Scholars have assumed that groups of words reveal underlying themes, and that, for instance, co-occurrences of keywords can be interpreted as reflecting association between the underlying concepts (Weber, 1990). The current study adopted a conventional approach to content analysis. Using content analysis enabled the researcher to include large amounts of textual information and systematically identify its properties, e.g. the frequencies of most used keywords in context by detecting the more important structures of its communication content. In the study, coding of the transcribed documents involved open coding of meaning units, that is, words, phrases, sentences, paragraphs, which essentially involved labelling concepts. The emerging concepts were mapped into themes. The themes have been cross-checked on group discussions between the research team and four fellow researchers. The unit of analysis adopted for this study was the UAE 'construction industry', and the embedded unit of assessment was the 'individual employee'.

4.11 VALIDITY AND RELIABILITY

Greenwood and Levin (2005) offered a succinct definition of validity in qualitative research: 'validity is measured by the willingness of local stakeholders to act on the results thereby risking their welfare on the 'validity' of their ideas and the degree to which the outcomes meet their expectations. Miles and Huberman (1994) referred to validity with terms such as internal validity and external validity. Internal validity refers to the accuracy and trustworthiness of the information. That is, whether it represents the participants' reality. In other words, internal validity addresses whether the findings are credible (Creswell, 2003). In this study, threats to validity were minimised through triangulation of data collection methods (interviews, internal and external documents) and verification of the initial thematic codes by participants, where they judged the accuracy of data collected, though not its conclusions (Tajeddini and Mueller, 2012).

External validity explains how generic the research findings are beyond the cases used in the study (Yin, 2003). External validity has been an important issue and the number one subject of discussion when discussing the quality of qualitative research. Yin (2003) notices that critics typically claim that no generalising can be undertaken on the basis of a few cases, let alone a single case. As to the external validity, the results of this study remain limited in their generality, irrespective of the triangulation.

4.12 THE DEVELOPMENT AND VALIDATION OF A FRAMEWORK MANAGING SUSTAIABILITY STRATEGIES

The empirical findings from the previous stages of the research study and aspects from critical review of literature were taken into consideration in the development of the framework. In this study, during face-to-face interviews, interviewees were asked the need for development of sustainable assessment framework for sports sector organisations. Of the interviewees, 95% (42 of the 44) cited the need for a holistic, comprehensive framework for addressing the issues relating to both the uptake and implementation of sustainability strategies. Therefore, development of a framework for managing sustainability strategies in the UAE construction organisations was developed and validated (see chapter 10). The developed framework provides broad guidance for the integration of sustainability strategies into day-to-day operational decisions.

The developed framework was validated with 10 senior professionals, who had over 15 years of work experience in their organisations. The professionals had been informed by e-mail about the objectives of the research study and aim of the framework. Also attached to the email was the developed framework. This e-mail was sent one week prior to the face-to-face interview so as to create an opportunity for the interviewees to review the developed framework. The experts selected were required to provide comments on the developed framework. All face-to-face interviews were recorded with permission and later transcribed. As part of the analysis of the interviews, content analysis was employed.

4.13 SUMMARY

This chapter provided an overview of the research methodology and procedures used in the acquisition and analysis of empirical evidence used to determine how the UAE construction organisations are managing sustainability strategies for the competitive advantage. The chapter also explains why and how qualitative methodology was adopted for this research study. Content analysis was used to analyse qualitative data. Results from the analysis of qualitative data are discussed in Chapter 5, Chapter 6, Chapter 7, Chapter 8, Chapter 9, and Chapter 10.

The next chapter (i.e. Chapter 5) will discusses the perceptions of the UAE construction sector on the concept of sustainability and key drivers that have fuelled the need for implementing sustainability strategies in the UAE construction organisations.

CHAPTER 5 : THE PERCEPTION AND DRIVERS FOR IMPLEMENTING SUSTAINABILITY INITIATIVES

5.1 INTRODUCTION

This chapter explores the perceptions of the UAE construction sector on the concept of sustainability and drivers that have fuelled the need for embedding sustainability strategies. The discussion is based on qualitative data obtained from 44 construction professionals. The results are presented in two parts. The first section presents an analysis of qualitative data in relation to perception of UAE construction sector on the concept of sustainability. In doing so, this section addresses the first research objective of the current study, which is “to investigate and document the perception of UAE construction sector on the concept of sustainability” and first research question, which is “what does sustainability mean to UAE construction organisations?”.

The second part in section presents an analysis of qualitative data in relation to the drivers for embedding sustainability strategies in the UAE construction orgnaisations. In doing so, this section addresses the second research objective of the current study, which is “to explore and document the key drivers for implementing sustainability initiatives in the UAE construction organisations” and second research question, which is “what are the key drivers that have fuelled the need for implementing sustainability initiatives in the UAE construction organisations?”.

5.2 PERCEPTION TOWARDS THE TERM "SUSTAINABILITY"

The following Table 5.1 shows the data obtained from the first question which was related towards obtaining elaboration on the interviewee's perception on sustainable development. It is crucial to primarily understand the interviewee's views on what sustainability involves and what it means, this is crucial as misunderstanding of sustainability is one of the key reasons why it's implementation is hindered (Renukappa, et al., 2012: Sourani and Sohail, 2012). As demonstrated by the literature there are problems and inconsistencies that can be obtained when sustainability is acted upon in a manner outside of triple bottom line, as was seen by the scepticism of Redclift (2005). This will also serve to provide a better understanding of what outcomes they expect from sustainable development and business value if any they see in adopting sustainable initiatives.

Table 5.1: The perceptions of UAE construction organisations on the concept of sustainability (N=44)

Sl.	Sustainability dimension	Total number of interviewees cited (N=44)
1	Environment	73% (32/44)
2	Economic	70% (31/44)
3	Social	64% (28/44)
4	Triple Bottom line	27% (12/44)

5.2.1 ENVIRONMENT

In this study, 72% (32 of the 44) of the interviwees noted the sustainability in line with environmental aspects. When asked regarding their perceptions of sustainability interviewees responded with comments on energy management, carbon emissions, wastage and resources management indicating the environmental aspects of these issues. This is expected as Renukappa, et al. (2012) states the high emphasis of attention given towards the environmental aspect of sustainability. This is also evident as the environmental aspects were highlighted as second highest amongst principles within sustainable development definitions (Gagnon et al., 2009). It can be seen how UAE construction organisations commonly do not have a clear definition towards the term of sustainability and majority of the interviewees stated that their organisations defined sustainability with the international definition of WCED (1987).

As mentioned it is easy to understand why environmental issues are emphasised highly as Zabihi, et al., (2012) noted initial basis for sustainability was based on energy usage and reducing damage to the environment. The environmental aspect of sustainability is highlighted by concerns over issues such as climate change where attention towards energy usage is raised. This is due to extensive pressure from the government and environmentalist causes which has caused a greater awareness towards environmental issues. For instance, Dixon (2009) denotes the act requires the government to publish five-yearly carbon budgets create an advisory committee on climate change, assess the risk to the UK from impacts of climate change, and provide powers to establish greenhouse gas trading schemes. Sustainability has grown to include other aspects involved in its makeup as noted by Zabihi, et al., (2012) and the data obtained, where it has grown to include issues such as cost reduction, materials and societal advancement. However environmental concerns remain synonymous with sustainability evident in this statement by an interviewee:

> “Sustainability is the term that embodies the practices that would enable any corporation, organization or project to have minimum impact on the environment and be able to reduce its

> carbon footprint and any factors that would harness the environment. It also involves allowing a project to function in harmony with the planet”.

Another interviewees noted that:

> “Obviously the other meaning of sustainability tends to be connected with energy use.”

Here the interviewee remarked that sustainability’s relation the environment and energy emissions are obvious, glossing over this issue, indicating this is the supposed perception of sustainable development and it should be expected to be said.

Barthorpe (2010) denotes the criticism and involvement towards environmental problems as perceptions of the construction industry. The high emphasis towards the environmental aspect of sustainability could be the result of attempting to undo the bad reputation highlighted by Barthorpe (2010). The reason why the construction sector has lower emphasis towards environmental aspects could be due to there being one less interviewee. Also the interviewee who didn’t highlight environmental aspects detailed triple bottom line which contains environmental consideration in balance and in tandem with the two other pillars of sustainability.

5.2.2 ECONOMIC

In this study, 70% (31 of the 44) of the interviwees noted the sustainability in line with economic aspects. This high emphasis towards the economic aspect of sustainable development contradicts the literature where Renukappa, et al. (2012) indicates that economic dimension was only highlighted by 24%, noticeably different to the 70% from this study. The fact that this study contains a noticeably lower sample may also contribute towards this outcome.

Despite the findings indicating environmental and economic factors are equal, they are not completely unexpected or out of place. When Zabihi, et al. (2012) states some of the aspects of sustainable architecture and construction are construction expenses, resource efficiency and energy efficiency. All these mentioned attributes contribute towards effective methods of minimising expenditure, a welcoming prospect considering the economic difficulties faced the past few years. As the concept of sustainability developed beyond the environmental concept to include issues such as cost reduction and materials. Considering sustainability is commonly associated with actions such as resource efficiency, energy efficiency and cost reduction it is clear the economic benefit is placed alongside longevity in order to reap these benefits. An interview statement obtained demonstrates the importance longevity to the point the interviewee discredits environmental aspects through energy saving:

> "From a design point of view with sustainability in mind we're looking at designing with a view of creating a product that has longevity and minimises impact both in construction and in us. I don't think it's about energy you've got to create buildings people want to keep."

Another interviewees noted that:

> "Sustainability addresses issues within a long term perspective resulting in an increase of construction costs".

This highlights the economic view point of ensuring there is a saving on demolition, refurbishments and maintenance allowing for greater saving of finance. This perspective of sustainability is taken further where finance is the determining factor whether a project is sustainable. This economic element of sustainability was aptly highlighted in the following statement made by an interviewee:

> "It has a number of meanings, obviously we want to whenever possible work on projects that are going to be sustainable and in the context of housing the first thing about it is we need to create places where people like to live because if they don't like to live there it is completely unsustainable."

This quotation provides detail into the interviewee's perception of sustainability, indicating the need to act on ideas that can only be sustained through demand and therefore finance. This correlates with an argument provided by Aras and Crowther (2009) stating that sustainability can only exist if equity in the distribution of effects also exists.

5.2.3 SOCIAL

In this study, 64% (28 of the 44) of the interviwees noted the sustainability in line with social aspects. The lack of perception towards social dimension was evident from the literature obtained, Renukappa, et al. (2012) states 0% of the construction industry representatives highlighted cooperate social responsibility aspects from sustainability. The lack of emphasis towards social aspects although expected should not be so drastic. The original statement from the Brundtland commission (1987) signified the importance of preserving future societies drawing attention towards social aspects. Also the fact that

Gagnon et al. (2009) identified social aspects to be the most common principles pertaining towards definitions of sustainability provides a contrast to its implementation within the industry.

Social responsibility is to look at the how the project will benefit society, the impact it will have on local community and overall taking a holistic view in determining the wide ranging effects caused. The following extract from an interview demonstrates taking the social aspect of sustainability into consideration:

> “Then there is access and linkages how we could get people there easily. Then there is creating safe communities and local character heritage, how does this mosque fit into the surrounding area.”

Another interviewees noted that:

> “It refers to the use of resources responsibly, leaving enough provisions for the future generations, and also has to do with creating the less possible negative effect on the society”.

This demonstrates clear thought being given towards how elements of the projects will have a long lasting effect upon the surrounding community, considering communication routes and surrounding area. This identifies with Porter and Kramer (2006) where there is shared value between the community and the business which is looking to be utilised for competitive advantage.

The lack of emphasis towards the social dimension matches the literature where Porter (1989) states that businesses are not equipped to deal with social problems but rather this is the responsibility of government bodies and NGO's. Renukappa, et al. (2012) also states why social responsibility may not be a key factor in projects due to these issues only becoming prevalent from stakeholder pressure.

5.2.4 TRIPLE BOTTOM LINE

In this study, 27% (12 of the 44) of the interviwees noted the sustainability in line with triple bottom line aspects. As previously highlighted within the literature triple bottom line follows the perception of sustainability most compatible along with competitive advantage due to being the most holistic and inclusive perception. Triple bottom line occurs when the social, environmental and economic factors are emphasised with equal measure alongside each other and realising that the three aspects are interlinked. Hence an interviewee's perception towards triple bottom line was only noted when the interviewee the equal standing and interconnectedness of all three pillars.

Triple bottom line as mentioned is the approach that the three dimensions, economic, environmental and social are all pillars of sustainability as illustrated in the definition provided by Young (1997). These principles were highlighted in the following quote obtained by an interviewee:

> "Sustainability in that sense is important, sustainability for us is finding the balance of economy, society and environment, the three pillars of sustainability."

Here the balance and equality was emphasised according to the triple bottom line perspective. This viewpoint is allows for greater systems approach looking at allowing for greater consideration towards the whole and not just the parts (Ackoff, 2010). As demonstrated it is understandable why organisations would want to implement a triple bottom line approach as it allows for an in built receptive culture being developed, focusing on the needs of the environment and society without compromising the economic stability of the organisation. The reason why the data may not show a considerable perception towards triple bottom line is most likely due to the highly environmental focus of sustainability seen in the focus in legislation. This also indicates a lack of operational understanding as seen towards the understanding the cohesiveness between the range of issues (Renukappa, et el., 2012).

5.3 THE KEY DRIVERS THAT HAVE FUELLED THE NEED FOR IMPLEMENTING SUSTAINABILITY INITIATIVES

In this study, during face-to-face interviews, in order to capture the drivers that have fuelled the need for implementing sustainability initiatives, a question was raised, i.e. what are the key drivers that have fuelled the need for implementing sustainability initiatives in the UAE construction organisations? Drivers cited by the interviewees in this study include: costs reduction, attracting clients, legislation, management commitment, and to improve reputation.

Table 5.2: The key drivers that have fuelled the need for implementing sustainability initiatives (N=44)

Sl.No	Key driver for implementing sustainability initiatives	Total number of interviewees cited (N=44)
1	Costs reduction	82% (36/44)
2	Attracting clients	80% (35/44)
3	Legislation	73% (32/44)
4	Management commitment	66%(29/44)
5	To improve reputation	57%(25/44)

5.3.1 COST REDUCTION

In this study, 82% (36 of the 44) of the interviewees noted that cost reduction was the most important key drivers for implementing sustainability initiatives in their organisations. Identifying this as a driver shows how organisations are viewing sustainable developments demonstrated by the fact that cost reduction is a key driver according to the data and also identified as a key strategy for competitive advantage (Porter, 1985**;** Martinez, et al., 2018).

Materials such as steel are able to be recycled and reused once placed in a structure, allowing for cost effectiveness and resource efficiency. This was highlighted by an interviewee that:

> "Whether we are using steel or concrete which once it is set you can't really reuse it again whereas with steel you can take it down 40 or 50 year life span, recycle and reuse it."

Undertaking this approach fulfils some of the criteria of reducing waste detailed by Lu and Yuan (2011), namely reducing waste through design and improving the practitioner's attitude towards waste. It also matches with certain criteria for sustainable architecture detailed by Zabihi, et al., (2012) through efficient planning and minimising construction maintenance. Once again this demonstrates operational effectiveness where effective and efficient choices display qualities of operational effectiveness and distinctive competency.

Sustainability is a balance between economic, environmental and social aspects hence it is crucial to look at all issues and place issues under perspective. Exerting effort into a more expensive and time consuming structure due to material choices may lead towards an imbalance of the three pillars. Implementing a more complicated sustainable design where costly delays occur provides a hindrance and not an advantage. Similarly it is crucial not to overdesign any structural elements ensuring project is financially viable.

Implementing renewable energy sources appears to fulfil the requirements of competitive advantage. It allows for the reduction of cost alongside efficient use of resources to form a distinctive competency, both are components of sustainable development. The following quote from an interviewee within the construction sector describes the methods undertaken to reduce energy use:

> "We're looking at trying to make buildings more passive, the new business school next door that we're looking at we're moving away from a mechanical system to a more naturally ventilated and that's we're trying to get more issues."

The interviewee describes a successful method of reducing energy usage through the development of natural ventilation systems which provide noticeable cost reduction in saving of ventilation systems required to be implemented through the building. This also results in operational effectiveness where the efficiency is achieved in order to receive a feature required for a building for no continual cost, providing an innovative solution to a problem.

Waste management was also highlighted as a cost reducing measure as indicated by the following quote:

> "This allows us to drive things forward looking at waste management diverting waste from landfills which is a key area."

This gives room for efficient use of resources through reuse or recycling, saving on transportation cost and also reducing waste sent towards landfill also contributing to cost savings from less landfill tax (Tam, 2008).

The prospect of reducing costs through efficient practices would be desirable to any organisation hence the high emphasis within the data. As highlighted by Porter (1985) cost reduction is an element of competitive advantage hence it is understandable why it is considered as a desirable outcome and driver for sustainable development. Bansal (2005) where environmental issues are seen as opportunities demonstrated by the data where costs and environmental impacts where reduced from effective use of materials, energy and waste.

5.3.2 ATTRACTING CLIENTS

In this study, 80% (35 of the 44) of the interviewees noted that attracting clients was the another most important key drivers for implementing sustainability initiatives in their organisations. Many clients have pre-set conditions where they seek to implement sustainable measures and pass these on to the contracted construction companies they utilise. This is found amongst organisations which have the government as their clients when providing work towards the infrastructure. Due to the government's position as an industry leader looking to bring about change and drive "best practice", construction companies pay heed towards the sustainable requirements needed (Manley, 2006). This found in the following quote provided by an interviewee within the construction industry:

> "Majority of people work for government clients and that's why it's extremely high on their agenda and is extremely high on our agenda."

Sustainability is a key priority for the government and as found by their commitments towards achieving targets such as targeting all new homes from 2016 to be carbon neutral (DCLG, 2012). Considering the role of government to appease the people and serve to better the people it is clearly evident how being sustainable would increase the likelihood of obtaining them as a client. This confers with Roarty (1997) along with Rodriguez-Melo and Mansouri (2011) where an increase in "green" clients due to changes in perception has means an organisation has to adapt in order to appeal to them.

The opportunity for saving finance is also another aspect of sustainability which is utilised with the aim of attracting clients. This is due to a tradition of bidding based on cost as highlighted by (Sadreddini, 2012) where any reductions obtained can be passed on to the clients. This is aptly highlighted in the following quote obtained from an interviewee:

> "If you can implement sustainable options that are financially viable that make saving if you manage to procure through having just enough material it allows you to bid cheaper for projects with the assumption that you're saving costs"

The following quote clearly demonstrates how the use of sustainable measures transfers benefits when bidding for projects. This shows operational effectiveness where the manner in which company operations are conducted is better than your rivals resulting in reduction of cost. It is not just important for the client to acquire the project at its lowest price but for lower total costs taking into account the whole life cycle of the project (Abi-Karam, 2006). This is again emphasised by an interviewee who stated:

> "I suppose there is a cost implication, if a client knows they are going to keep the building for a while and the initial outlay is larger than if it's going to save them money in the long term then they are more likely to invest in alternative energy sources etc."

This matches along with two of the criteria described by Ambec and Lanoie (2008) in achieving operational effectiveness which are lower costs of materials, energy, and services along with lower costs of capital making up a part of a competitive advantage.

It isn't just the prospect of cost reduction and ethical work why firms expect to attract clients through the use of sustainable development. Sustainable development attempts to improve all aspects of society, environment and finance providing real benefit to communities and also the clients. This was identified in a quote obtained from an interviewee within the construction sector:

> "We have to provide real tangible benefits to businesses and our clients."

This is due to sustainability being a more holistic approach then taking into account a range of details spanning outside the cost and time constraints and determine the impact of development projects in the long term. When looking at four objectives of sustainability highlighted by Masood (2007) consideration is given towards social benefit, economic growth and employment. A firm looking to implement these objectives would see also provide benefit to their clients. This is further elaborated in a quotation from an interviewee that:

> "The second heading is involving the community then is maximising economic opportunities and that is particularly relevant to our industry, mosques and Islamic centres, sustainability means you have to help them pay for themselves."

Working towards improving client's financial system helps towards improving the society, improving finances for community building and non-profit organisations, meeting some of the requirements of sustainable development. However this also demonstrates effective understanding of the client and their needs understanding how the client interacts alongside the environment and the surrounding community. This corroborates with a statement obtained from Rodriguez-Melo and Mansouri (2011) where they manager from a construction company highlighted sustainability is first developed by obtaining a working relation with the client. This was further expanded upon within the same interview when the interviewee said:

> "I think we have to demonstrate we have an understanding again it is not just the planning and building of something, the project starts for the client when the building is completed and it is having an awareness of that."

Taking this approach matches alongside the definitions provided by the Brundtland commission (1987) where it provides clients a means to meet their own needs. This demonstrates how undertaking a holistic/systemic view through sustainability allows for greater understanding on the project and the nature of the project upon completion. Following this perspective allows for greater consideration towards stakeholders including the clients which ultimately works towards a demand driven attitude leading towards integrated approach, enhanced innovation and improve managerial competencies (Lindahl and Ryd, 2006). This allows for greater value to be obtained through improved knowledge and practices, with the repeat use from clients apparent from the 80/20 model (Abi-Karam, 2006) and also provide referrals.

5.3.3 LEGISLATION

In this study, 73% (32 of the 44) of the interviewees noted that legislation was the key driver for implementing sustainability initiatives in their organisations. Key to this outlook is government legislation which dictates how the industry must move forward. The government has recognised alongside the international community sustainable development needs to be become a key factor in order to address key problems such as climate change. The emphasis and attention towards sustainability is made clear in the following statement, “Our long term economic growth relies on protecting and enhancing the environmental resources that underpin it, and paying due regard to social needs. As part of our commitment to enhance wellbeing”. This illustrates the government has identified that change is required in order to address the problems facing future generations by making sustainability a way of life. The following quote demonstrates this:

> “Just as leading businesses recognise that sustainability is a core strategic issue and not just a ‘nice to have’, this Government wants to mainstream SD so that it is central to the way we make policy, run our buildings and purchase goods and services”.

Hence the government has encouraged sustainability within the UAE construction industry as it recognises the necessity of it to be implemented within society along with strategic value. For instance, in 1997 UK committed themselves to the Kyoto protocol, an international treaty with the aim of reducing developed countries greenhouse gasses emission. The 2008 climate change act was the first legally binding climate change target aiming to reduce carbon by at least 80% in 2050 according to the 1990 baseline. This has further been expanded to numerous legislation and targets being put in place and implemented with the target of reducing carbon such as targets set to have all new homes carbon neutral by 2016 (DCLG, 2012).

Related to these targets and goals the code for sustainable homes was introduced in 2006, although the requirements from these codes is voluntary however level 3 energy standards have been incorporated in the building regulations. Following the voluntary regulation is seen as a way to adapt into the changes to be made, this is the view of a director from an architecture firm when stating:

> "What the code has been doing is in fact trailblazing the approach that is coming through in building regulations and there is every chance in the next 12 months the code will actually be abandoned, all we've learnt form the codes will be put into the building regulations which will be a mandatory thing for the whole of the building industry not just the bit that builds affordable houses."

An approach by companies to simply follow regulation would not lead to competitive advantage because ultimately they are just reacting to requirements instead of proactively seeking to innovate as indicated by Glass (2010). However this isn't demonstrated by the quote obtained from the interviewee. As following voluntary legislation it allows for the firm to realise the most efficient methods to implement the sustainable measures, allowing room for error as the legislation isn't compulsory and doesn't have to be upheld. This gives organisations time to prepare for changes made towards the compulsory legislations, as has been the case with level 3 energy standards being incorporated into the building regulations. This trend is set to continue and is demonstrated by the quote made by the interviewee. The development of legislation is expected amongst professionals within the construction industry and what this demonstrates is their proactive approach. The proactive approach undertaken by organisations reflects the proactivity of the government where they have looked to reach forward in time and prevent the problems being faced rather than simply reacting as a problem arises (Fehr, et al., 2009). In fact an interviewee remarked that legislation was the key driver for sustainability and the future of sustainable development is dependent upon the legislation introduced.

As sustainable initiatives spread and become mainstream they become the required standard expected within the industry. This is further emphasised in the following quote:

> "It isn't something we necessarily look at to use as something to set yourself apart I think it has become part of the industry. 10 years ago it could be used as a means of marketing yourselves but today it is very much expected to be taken into account and consideration."

Sustainability is considered as innovation (Seabode, 2012) within the industry where typical attributes placed alongside sustainability from the data and literatures are resource efficiency, social impacts, holistic/systemic perspectives and economic stability. When competing organisations are looking to implement these values it is necessary to adjust in order to survive (Schjeldahl, 2013). Also contributing towards the mentality of sustainability increasingly becoming a requirement for the industry is the changes of industry perception towards sustainable development. In recent times there has been a greater awareness of sustainable issues once again encouraged through legislation but also seen through the education of engineering, construction and architecture courses.

5.3.4 MANAGEMENT COMMITMENT

In this study, 66% (29 of the 44) of the interviewees noted that management commitment was another important key drivers for implementing sustainability initiatives in their organisations. This driver is related towards socially proactive organisations where management support is given towards environmental and social issues. Statements related to this driver are seen as management commitments being adhered to by members of the organisation.

Top management commitment is crucial towards addressing sustainable issues due to top management having the ability in persuading organisations (Sarrakh, et al., 2019). The commitments undertaken are seen as the responsible course of action to by managers given their roles (Renukappa, 2014). Some of these commitments may not emphasise any overt perspective to allow for sustainability initiatives to be utilised providing an advantage but rather due to a responsibility felt by managers.

When examining certain statements made it is apparent that they can be seen from an altruistic point of view, as seen in the previous statement where sustainability is seen as a responsibility leading towards personal satisfaction. This can also be seen in the following statement:

> “We try to encourage people to use the bike, there is a cycle to work scheme for staff and we try to say use public transport as

much as you can, however a person driving would always want to park outside the building."

Here it can be seen that the increased use of public transport would not serve to improve the organisation in a strategic or business sense. This comes from a desire to improve society and contribute towards lessening environmental impact. This contradicts views of Caroll (1989) and Kanugo and Conger (1993) where the key commitment of a business is to focus on margins and social responsibility is deemed an arena outside business suitable for the government. However the interviewee in a position to implement a change does so within the boundaries of practicality, the cycle to work scheme although not providing overt strategic benefit would not be a constraint towards the organisation. Hence it ultimately comes down to the management's ethical desire to create a culture of responsibility where sustainability can flourish.

The management responsibility towards sustainability allows for fresh perspectives towards to be obtained where a number of alternative solutions to achieve these goals are illustrated. This is shown in the following quote:

> "I recently went to a seminar and one the engineers presenting actually said if the council has put these conditions in your application, you go challenge them, they're trying to get us to put PV's on our roofs if they went and changed all their cars over to using biodegradable fuel that would be a lot more beneficial for the environment. So it is getting people to think outside of the box."

Here the interviewee demonstrates a different perspective towards sustainable initiatives, rather than blindly following regulatory procedures this allow for looking outside the box to solving problems from a different outlook. This matches with the holistic approach required within sustainable development examining the sum of all the parts rather than individual segments through a reductionist approach.

Management commitments are necessary for the transition of efficient systems focused on resource management and cost reduction alongside leadership, culture, innovation and resources (Renukappa, et al., 2014). Therefore it is easy to understand why management commitments were highlighted as 66% from the data. This could be due to these factors seeking to respond towards the perceived criticisms facing the AEC industry as highlighted by Barthorpe (2010). With Engineering and Construction fields more visible involvement towards the perceived criticisms as they spend greater amount of time on building sites. The high emphasis within these sectors could be due responding towards the criticisms faced a factor could be that the architecture companies are focused towards the financial aspects of sustainability due to being SMEs with greater funds available and more financial pressure.

5.3.5 REPUTATION

In this study, 57% (25 of the 44) of the interviewees noted that to improve reputation was the important key driver for implementing sustainability initiatives in their organisations. Focusing on reputation is crucial towards focusing on a developing the corporate brand by focusing on environmental, social and economic responsibility issues (Renukappa, 2014). This focus is seen in the following quotation obtained from an interview:

> “If we are committed towards employing young people or people not in work, then we need to do that and show that and that reporting and feedback to our clients is the key thing at the moment.”

Here it is demonstrated that value is placed upon an organisation operating in a responsible and truthful manner. This allows for the organisation’s integrity not to be called into question as they fulfil their goals and objectives and simultaneously show they act on their initiatives. A statement provided from the interviewee serves to provide greater insight into why reputation of an organisation is seen as a driver:

> “Whereas a few years ago it may have been lip service, now we have to really go and act on these initiatives.”

This highlights how as sustainability is becoming increasingly utilised and adopted by organisations, simple rhetoric is not enough to illustrate that an organisation works to sustainable values. This has made has led to a greater use of sustainable initiatives as the companies would want to prevent their reporting being labelled as greenwashing (Van, 2011).

The issue of company reputation although has the potential to benefit organisations through the development of corporate brand and empirical evidence suggesting companies with reputations for sustainability have a higher market valuation (Lourenço, et al., 2013). However reputation is seen as a key factor towards companies that rely on intangible assets such as creativity, innovation, intellectual capital and high levels of service as the basis of competition (Renukappa, et al., 2014). The mentioned intangibles are seen as necessary needs for the construction industry and are also strongly tied in alongside sustainability which is why it was indicated amongst the data. Also contributing towards these findings is the need to undo the criticisms of social and environmental against the construction industry.

5.4 SUMMARY

It could be noted that, although the importance of sustainability is broadly acknowledged within the UAE construction sector, there is a significant lack of a common and operationalised understanding on the concept of sustainability. In the long-term, construction businesses should be aiming to create more openness in acknowledging and addressing the issues of sustainability. Therefore, sector-wide awareness rising programmes on the concept of sustainability needs to be implemented. As illustrated from the literature triple bottom line approach is the most compliant approach towards obtaining competitive advantage, due to its holistic/systemic principles and balance of all factors. The triple bottom line approach wasn't emphasised highly amongst the data however the environmental and economic dimensions of sustainability were the most highlighted. Many of the interviewees displayed both these dimensions within their perceptions of sustainability, illustrating how the economic and environmental aspects could be reconciled. The fact that the social aspect wasn't highlighted more is at odds with the rest of the data where management commitment proved to be a significant driver for the organisations. Contributing towards this inconsistency is likely to be a lack of education towards the triple bottom line approach as highlighted by (Renukappa, et al., 2012) and Sourani and Sohail, (2012). It is likely interviewees were more familiar with the earlier interpretations of sustainability were there was a strong emphasis towards the environmental side (Zabihi, et al., 2012). Also with the government legislation having an imbalance towards the environmental aspects these factors may have led the interviewee to feel this would have been right answer to provide.

Throughout the data there has been a strong undertone towards the economic aspects of sustainability. Where for each question the most emphasised aspects an economic perception of sustainability, cost reduction as a driver and outcome along with costing as the biggest challenge facing the implementation of sustainable initiatives. This demonstrates a conscious attitude towards attaining competitive advantage from these measures, illustrating the potential for operational effectiveness and cost reduction provide a significant part of the reason why sustainable measures are implemented. Cost reduction which was the most important driver and is a means of obtaining competitive advantage (Porter, 1985). As demonstrated by the results cost reductions were largely attained through efficient management of resources such as energy, waste and materials, these methods expand on the benefit of cost reduction and also attain the organisation operational effectiveness.

The prominent feature of cost reduction alongside sustainable development is not unexpected as eco- efficiency is a basic component of sustainability (Savitz and Weber, 2007). Eco- efficiency is the link between both concepts of competitive advantage and sustainable development, this is shown through a description of eco- efficiency by Lifset (2011). Lifset (2011) describes eco-efficiency as the creation of value with a decrease in environmental impact with a focus towards dematerialisation of resources and emissions. This allows for fresh ideas and perspectives to thrive, providing innovative solutions utilising natural ventilation systems and rainwater harvesting in order to utilise nature to cut the utilities costs. Demonstrating how a lower cost dimension is pursued through improved energy efficiency, waste reduction, lower materials costs, and higher productivity matching with the views of Gupta and Benson (2011). The emphasis towards cost reduction was also shown in the two initiatives of waste management and energy savings. This indicates how cost reduction and efficiency are principles embedded within sustainability. These initiatives were not the most emphasised, likely due to towards interviewees not committed to energy saving and waste management beyond the cost reductive potential.

Five key drivers have fuelled the need for implementing sustainability initiatives. They are: costs reduction, attracting clients, legislation, management commitment, and to improve reputation. When examining the drivers many of them displayed the expected competitive advantage the companies expected to obtain. Many of the drivers seek to add value into the organisations, the most notable example of this was the driver of attracting clients. Implementing sustainable measures with the goal to attract clients clearly provides a competitive advantage as sustainability is a real world requirement (Aritua, et al., 2008). An organisation operating effectively while minimising the drawbacks would clearly provide the clients with a number of advantages. Roger (2008) revealed that clients act as drivers for innovation which was highlighted as alongside sustainability from the data obtained. In addition Roger (2008) determined that clients ensure projects are economically viable, technically functional and socially acceptable, matching two criteria for a triple bottom line approach of sustainability. The environmental aspect could be an extension of the socially acceptable side further providing matching criteria along a triple bottom line approach in sustainability indicating the importance towards clients. Clients recognise the importance of added value through and are willing to pay more when sustainability is utilised for increased innovation instead of simply a cost cutting measure (Kulatunga, et al., 2011). This is highlighted by a shift away from the dominant lowest bid tradition towards a more value driven process (Waara and Brochna, 2006) where sustainability is given a greater priority.

Operational effectiveness as discussed earlier allows for a number of methods where value is added through the reduction of cost and efficient practices (Flint, 2000). This also translates to attracting employees where the cost reductions are developed into a distinctive competence (Mooney, 2007). If the organisations attempt as attracting more customers is realised then this would provide a clear case of competitive advantage being achieved through the adoption of sustainable measures. Adhering towards proving quality is something that is lacking into and working towards this undertaking a holistic/systemic view allows greater client communication and quality obtained through meeting their requirements. This is recognised as the culmination of all other aspects of sustainable development discussed such as innovation, cost reduction and keeping up with the industry being bought together to result in additional value being obtained to the organisation.

The results demonstrated that a number of interviewees view sustainability as a crucial part of the industry as demonstrated by a number of statements. There are a number of reasons for this with the primary reason being legislation. Keeping up with government legislation is seen as a major driver from the data, this may seem to contradict with competitive advantage as it is forced upon the companies to use these initiatives. If an organisation received benefit from implementing certain factors they would not need to be forced by the regulation to act according to the sustainable initiatives giving weight to claims from Ambec, et al. (2010). Also differentiation is an aspect of competitive advantage highlighted by Porter (1990) but when all organisations implement sustainability this decreases the impact of this factor. This does not mean that there can be no means of differentiation as an organisation an act on environmental and social aspects exceeding legislation and standards. The fact that organisations are forced to comply with regulation and industry changes does not necessarily mean that this removes the prospect for competitive advantage. According to Porter (1990) strict environmental constraints often enhance competitive advantage, describing government regulations and industry standards as a stimulus for competitive advantage ultimately leading to competitive advantage.

The industry is a dynamic environment where needs and requirements advance over time demonstrated by this study results however this is not the only reason why changes occur within the industry. Barney (1991) highlights any competitive advantage obtained and would be subject to methods of duplication and remains an advantage until it is successfully duplicated. This demonstrates how sustainability has spread through the industry which as discussed has been partially due to legislation but also through duplicating competitors sustainable measures. At one point it was targeted by organisations wanting to exploit a niche in the industry whereas now it is almost adopted by many companies who recognise the need to adopt these strategies. The fact that sustainable initiatives are imitated would indicate their initial success as a competitive advantage which is to be expected when it is attained. This clearly demonstrates demand for sustainable practices.

Legislation, industry standards and education have all been enforced upon organisations forcing them to adopt sustainable measures. This doesn’t provide a complete understanding of how sustainable development has on a whole been embraced by large organisation and integrated into mainstream culture. Atkisson (2013) details that although this change had occurred due to the embrace of two strategic principles. The first to respond to the impended crises being faced in order to safeguard the future, the second that they are wholly compatible with mainstream planning and management and will also lead to more effective and profitable methods of managing global civilisation in every sector. Although Atkisson (2013) later goes on to express uncertainty over the second principle it doesn't prevent organisations from valuing this as an achievable outcome as demonstrated by the data obtained.

As previously stated the social aspect of sustainable development wasn't particularly highlighted within the interviewee perceptions however certain social elements played their parts as a driver. Management commitment is a socially inclined aspects where the key emphasis engaging in sustainable activities because it is the responsible course of action. Applying social aspects of sustainability leads towards developing innovative services taking advantage of emerging markets (Jenkins, 2009). Emphasis towards the social aspects also allows for motivation and productivity to be built within the workforce (Kechiche and Soparnot, 2012: Zhao, et al., 2012). The social actions portrayed from the management commitments also serves to improve stakeholder relations alongside the clients and commercial partners (Kechiche and Soparnot, 2012: Zhao, et al., 2012). This causes a greater receptive ethos to be developed within the organisation where a holistic view towards projects is obtained.

The implementation of these social aspects is said to manifest in the organisation obtaining an improved reputation, this was emphasised equally within the data alongside management commitment. The socially motivated actions taken place contribute towards an enhanced corporate image and improved reputation (Collins, et al., 2007). An important aspect of this is the criticism faced by the AEC industry shown by Barthorpe (2010) detailing the lack of environmental and social concern. With the construction sector taking a more visible role in the developments they would feel the brunt of the criticism in comparison to the architecture sector. Hence it would be expected the construction sector would be increasingly concerned with reputation in order to undo the damage caused, however from the data it is clear that they have genuinely taken the criticisms on board. This is illustrated by the data demonstrating how every construction interviewee highlighted management commitment towards acting upon their responsibility. Further evidence towards the sincere social efforts undertaken by the construction sector was the lack of reputation as a driver, this is due to improving reputation being a self-serving task as illustrated by (Lähdesmäki and Takala, 2012). This differs with the construction sector representatives as they detailed they were motivated by serving and benefiting the society as their primary goal compared to any other driver.

Overall section 5.2 has addressed the first research objective of the current study, which is “to investigate and document the perceptions of UAE construction organisations on the concept of sustainability”. Therefore, section 5.2 has answered the first research question which is “what does sustainability mean to the UAE construction organisations”.

Section 5.3 has addressed the second research objective of this study, which is “to explore and document the key drivers for implementing sustainability initiatives in the UAE construction organisations”. Therefore, section 5.3 has answered the second research question which is “what are the key drivers that have fuelled the need for implementing sustainability initiatives in the UAE construction organisations” of this study. The next Chapter 6 will discuss the key sustainability initiatives that have been implemented in the UAE construction organisations to effect change.

CHAPTER 6 : IMPLEMENTATION OF KEY SUSTAINABILITY INITIATIVES IN THE UAE CONSTRUCTION ORGANISATIONS

6.1 INTRODUCTION

The purpose of this Chapter is to present the key sustainability initiatives that have been implemented in the UAE construction organisations. The results are based on the perception of the 44 participated interviewees. The findings are also substantiated with the relevant literature. In this study, interviewees were asked to list and describe key sustainability initiatives that have been implemented in their organisation through face-to-face interviews. This study revealed nine key initiatives under the umbrella of sustainability that have been implemented in the UAE construction organisations (see Table 6.1). In the order of implementation, they are: waste minimization strategies, lean construction techniques to promote Health and Safety practices, low carbon strategies, sustainable procurement strategies, equality and diversity strategies, workforce sustainability strategies, smart cities strategies, building information modelling and smart technologies strategies. Each of these key initiatives is discussed in details from section 6.2 to 6.10. Finally, section 6.11 summarises the key findings. In doing so, Chapter 6 addresses the third research objective, which is “to investigate and document the key sustainability initiatives needed to effect change that are currently being implemented in the UAE construction organisations” and third research question, which is “what are the key sustainability initiatives currently being implemented in the UAE construction organisations needed to effect change” of this study.

Table 6.1: Implementation of sustainability initiatives in UAE construction organisations (N=44)

Sl. No	Sustainability initiatives implemented	Percentage of interviewees cited (N= 44)
1	Waste minimization strategies	95% (42/44)
2	Lean construction techniques to promote Health and Safety practices	91% (40/44)
3	Low carbon strategies	89% (39/44)
4	Sustainable procurement strategies	84% (37/44)
5	Equality and diversity strategies	80% (35/44)
6	Workforce sustainability strategies	73% (32/44)
7	Smart cities strategies	68% (30/44)
8	Building information modelling	61% (27/44)
9	Smart technologies strategies	52% (23/44)

6.2 WASTE MINIMISATION

In this study, 95% (42 of the 44) of the interviewees noted that their organisations have implemented waste minimisation strategies as part of the sustainable construction practices in their organisations. Waste minimisation is also used as a cost reductive measure highlighted within the drivers but is also an initiative organisations are looking to implement. Waste management comes from the principles of operational effectiveness closely tied towards competitive advantage, where the treatment of waste is geared towards attaining the maximum value before disposal. This is seen in the following statement highlighting the interest in preventing waste from entering the landfill site:

> "We feel that when we do take a building apart and refurbish them in the future we're not going to send more and more to the landfill."

This fulfils one of the criteria from the waste policy of UAE is to primarily reduce the amount of waste developed. This also confers with a point made by Lu and Yuan (2011) where waste is reduced through design preventing waste being sent to the landfill and also saving costs on refurbishments.

Tam (2008) highlights the benefit of recycling waste where it reduces demand for new resources, cutting down transport and energy costs and utilising waste which would otherwise be sent to a landfill. These benefits are shown in the following quote obtained from an interviewee:

> "We take the raw material and waste and use some of it to strengthen some areas around the railways, so waste management is important to us."

Here waste which would have been transported of site remained close by to strengthen an embankment saving on costs to the site, cost of resource is saved and so is landfill tax saved from an efficient utilisation of waste.

The construction sector spends a greater amount of time working on site coming into contact with wastages, hence it is clear to see their initiatives were highly focused towards waste management. Architects deal from the design section undertaking a perspective where they consider refurbishments and the implications of the design but it is not a key their main objectives are not towards waste other then it related to systems such as water recycling and such.

A large part of ensuring a project is sustainable is waste minimisation. If a project is very wasteful then, by implication it is also inefficient as a large amount of resources have been obtained that will not be utilised for their intended purpose. Governments around the world are aware of this fact and are providing legislation to try and reduce the amount of waste that is disposed of by landfill. For instance, the construction and demolition sectors of the UK generated fifty nine percent of all landfill waste in 2014 (DEFRA, 2018) and if this value could be reduced, that would reflect a huge saving in disposal costs along with a reduced waste of potentially usable resources.

With the potential gains available if avoidably generated waste were reduced, there have been multiple studies published within the area giving suggestions on how to reduce waste though methods that include recycling, reusing, site and programme management along with construction techniques. Within the construction sector, and by extension, particularly within infrastructure works multiple different materials are used at different stages of the project. Once combined in the construction process, these materials are not compatible when it comes to recycling techniques and there must be considered contaminated and so needing disposal. There are methods that can be employed to reduce the waste generated which are able to cross material streams.

For example, while Hossain and Poon (2017)'s report is focused on wood waste, their analysis and conclusions based on real world sourced data can be transferred so that the methods for controlling generated waste and minimising can be applied to other materials streams. Their conclusions concur with the analysis conducted by Tam and Tam (2005) and their research based on literature reviews of ten different material waste streams, which in itself confirmed by conclusions reached by Ajayi et al (2016) who conducted an in-depth review of key site management practices from multiple sites before reaching their conclusions. The knowledge the multiple sites were used in the data gathering for Ajayi et al (2016) allows a measure of confidence in the report's conclusions and removes some concerns that could have been raised if a very small data sample had been used to extrapolate their results.

It is not only in the UAE that attention and research is being channelled into waste minimisation methods as a means of improving the efficiency of a site. Research carried out by Yu et al (2013) focuses on practices in use in Hong Kong while Esin and Cosgun (2006) conducted their research in Turkey. Esin and Cosgun (2006) conducted their research though surveys and literature reviews while Yu et al (2013) conducted a three year survey of various sites to ensure a large pool of available data for analysis and so remove any unconscious bias. That all reports, conducted in different ways and in different countries, return similar conclusions reinforces the knowledge that waste minimisation is an important and worthwhile aspect for consideration when it comes to the efficiency of a site.

Since the human race first started on infrastructure projects, with a few notable exceptions, most of Since the human race first started on infrastructure projects, with a few notable exceptions, most of these structures have a life expectancy and will need to be dismantled at the end of their design life to make way for the next generation. This fact coupled with the public's growing pressure on construction firms regarding sustainable construction practices has led to a large quantity of high quality reviews and research being conducted into how an infrastructure project should be decommissioned.

In previous decades, once a project had reached the end of its design life and needed to be dismantled, the preferred method of disposal was through disposal by landfill. There has been a large quantity of high quality, reliable research conducted into the downside of this practice in the recent years. Ajayi and Oyedele (2017), Colledge and Wilder

(2008) and Yang et al (2017) are just a selection of the available published articles that identify and corroborate the conclusion that disposing of construction waste by means of landfill is an incredibly expensive, inefficient, wasteful and environmentally harming solution to the problem and that there are other options available that should be utilised instead.

While some materials cannot be recycled and therefore must be disposed of via the landfill method, there are large quantities of available information and research that show the general industry is well aware of the shortcomings when using landfill to dispose of waste materials and is finding new means of recycling and reusing materials before resorting to disposing of them via landfill. Most of the governments of developed countries around the world have conducted research into the issues of landfill waste and published corresponding waste policies that reflect this fact and call for a reduction in waste being disposed of in this inefficient way. For instance, the UK government policy: waste and recycling (2015), European Environmental Agency – Diverting waste from landfill (2009) and Australian Government National Waste policy: Less Waste, More Resources (2009) are three such directives that all show governments are aware of the issues around using landfill and are influencing contractors into finding more efficient and alternative methods of waste disposal.

Lo Presti et al (2016), Zhao and Li (2016) and Robu et al (2016) through a combination of critical literature reviews, case studies and experimentation are just a few of the many academically published articles highlighting the benefits in cost and to the environment of recycling and reusing the different constituent parts of a road for future projects. This is a selection of a far wider range of peer reviewed and published articles all highlighting and reaching the same conclusion and so allows a reasonable measure of confidence that this area of possible construction efficiency improvements has been identified with research having been conducted into how the greatest benefits can be achieved.

The most environmentally friendly method is to ensure that the different constituents of the construction projects are recycled and reused in new projects, a point proven by a publication by Birgisdóttir et al (2016) when they conducted a life cycle analysis of different methods of disposing various constituent parts of a road. They only used two methods of disposal which doesn't allow for a great variation in samples which means their findings should be carefully considered before being quoted in the future.

It is important to have the correct process in place in order to ensure that the different road constituent materials are separated correctly, as currently once the different road layers (asphalt and road base aggregates) are mixed, the waste is classed as contaminated and must be disposed of, negating the ability to re-use in the future. Asphalt, which makes up the top layers of a road, is very easy to re-use once it has been removed at the end of its initial lifecycle and has the ability not only to be one hundred percent recyclable, but to be at the same specification and standard as it was when it was first laid, as highlighted through a mix of experimental and theoretical results in a publication by Byrne (2005) and separately by the European Asphalt Pavement Association in 2012. It should be noted that while there is corroborating evidence for the EAPA's report, the fact that they are trying to promote a product they use could mean that they are biased in their findings and therefore any results they issue should be independently checked and verified before being quoted further.

According to Akhtar and Akmal (2013), the construction industry is known for being a big contributor on making permanent changes to the natural environment, by abusing the use of natural resources and causing accumulation of pollutants in the atmosphere. Other negative impacts to the environment are: generation of waste, ecological imbalance, sewage and energy usage. The main type of waste produced in this industry is chemical and solid waste, which is produced throughout the whole process. One of the major causes of waste generation has been identified as the building material surplus. A construction project has different stages and the type of waste varies for each one of them. This is the reason why is it quite difficult to estimate the total amount of waste that is produced during the construction project. This amount of waste produced also depends on the site management efficiency and work procedures that are taken during the execution of the activities.

The building of a new structure, its renovation, repair, rebuilding or demolition is responsible for the generation of huge amounts of construction and demolition waste. This massive generation of solid waste, when not managed in a proper way, result to be very harmful for the environment. Previous research results by Salvatierra-Garrido and Pasquire (2011) demonstrate that the amount of materials wasted on constructions project is exorbitant; results estimate that more than 50% of the total project cost ends up going to waste. In other words, building owners end up paying double the price it takes to procure it.

According to Grogan (2011) the importance of waste management, or having a construction waste management plan in a construction, relies on the following benefits: Environmental: less landfill space and a fewer use of natural resources have a positive impact in the environment; Financial: optimization on materials use equals less money wasted; and Social: the public appreciates efforts to diminish negative impacts in the environment. It is also stated that to accomplish these benefits, integration of the teams that are delivering the construction project is essential. Integration here refers to a collective execution of the construction waste management plan and collaboration between them, having as primary goals to 'reduce, divert and recycle'.

Reducing the generation of waste and its recycle are considered to be the top priority in the waste management hierarchy. The recycling of construction waste has received attention in the last decade due to the numerous researches that have been done. In fact, multiple of these past researches show many alternative uses for recycled aggregates obtained from past constructions. On the other hand, reducing has been given less importance comparatively, but with the increase of disposal charges, nowadays there is an economical interest for developers and contractors to intervene in order to find alternative ways to reduce the generation of waste (Poon, 2007).

Marzouk and Azab (2013) reported that in past investigations held by Coelho and De Brito, (2013) and Zhao et al. (2010) it is definitely confirmed that an economically feasibility exist on investing for the recycling of construction and demolition waste. Even though they recognize that the initial investment tends to be high, an established return of the capital invested is expected to take place within two years. This is due to the colossal amount of waste generated and its high profitability that comes from its investment. On the other hand, regarding the environmental aspects, previous studies have been conducted to estimate what are the ecological impacts derived from construction and demolition waste recycling plants. Reports by Coelho and De Brito (2013) are fundamentally based on the energy consumption and the emission of CO2 for the evaluation of the harmful effects these contaminants have on the ecosystem. Positive results are shown, stating that “recycled materials always have significant environmental benefits where the avoided impact of CO2 emissions are always higher than the generated impacts and energy savings exceed the energy consumed during the operating lifespan” (Marzouk and Azah, 2013).

6.3 LEAN CONSTRUCTION TECHNIQUES TO PROMOTE HEALTH AND SAFETY PRACTICES

In this study, 91% (40 of the 44) of the interviewees noted that their organisations have implemented lean construction strategies to promote health and safety practices in their organisations. The UAE construction industry has been seen to provide increased risk to injuries and accidents for both the workers in the construction site and other people who may be passing by. This has led to the need of stringent measures to promote the health and safety of all the people concerned. In addition, the UAE construction industry has also moved towards the use of technology that increases productivity and minimises wastages. The use of lean technology has the potential of increasing productivity in the construction industry while at the same time promoting the health and safety of workers at the construction sites. The findings of this study were in agreement with several findings drawn from the review of literature regarding the use of lean construction and health and safety at the construction site (Alinaitwe, 2009; King et al., 2012; Pasquire and Gibb, 2009; Teizer et al., 2013; Zhang et al., 2013).

The most commonly used lean construction techniques in the UAE construction industry were visualization and Last Planner System (LPS). However, not all the components of these techniques were implemented in the construction process. The use of lean construction techniques in the industry was reported to provide several benefits to the projects and the firms. The factors that influenced the use of lean methods were reduction of project costs and duration, elimination of non-value adding activities, reduction of injuries and accidents, increasing productivity, and promoting safety at the construction sites. Out of these factors, the promotion of safety was noted as the first and most important benefit achieved form the use of lean construction methods. This finding is supported by Leino and Elfving (2011) and Ikuma et al. (2010) who found a relationship between lean construction and health and safety through prevention policies, respecting people and waste minimisation. Client satisfaction was noted as the least beneficial outcome of using lean construction techniques. Several authors, however, argue that shift in customer preferences as well as dynamism of the construction industry has prompted the adoption of lean construction techniques (Ashworth and Perera, 2010; Kelly, et al., 2014).

The research revealed that the most commonly used health and safety practice in the industry was having a health and safety manual at the construction site. Other practices included the provision of personal protection equipment, having a designated safety personnel, routine safety inspection, and provision of sanitation facilities. The least used practices include having height protection strategies, emergency procedures, and site access and boundaries protocols. This finding supports the findings of Mosly (2015) who established that emergency procedures, safety signage, and protection from heights were the least used methods in promoting safety in the Middle East construction industry. On the other hand, several challenges faced in the implementation of lean construction methods were established. The most vital challenge faced in UAE was lack of adequate knowledge on lean construction techniques followed by non-compliance to lean principles. This finding is supported by the study conducted by Ogunbiyi et al. (2013) who also found lack of knowledge as a key challenge among the UK firms. Lack of incentives was also found to be a major challenge faced in the implementation of lean techniques in construction to promote health and safety. An in-depth analysis of existing literature conducted by Bashir et al. (2015) examining UK firms and professionals support this finding. The four new challenges revealed by Bashir et al. (2015) included low effort to learn from employees, non-compliance with instructions, lack of incentives and high expectations from the management.

Several lean construction practices were established to be effective in promoting health and safety practices in the Saudi Arabian construction industry. The most effective strategies were the elimination of waste and errors, direct health and safety interventions, continuous improvement, communication, maintaining a clean, safe and efficient workplace, and improving work planning and forward scheduling. Several authors in literature provide support for this findings (Abdelhamid et al., 2013; Fernandez et al., 2012; Lim YenWui, Abdul Rahman & Abdul, 2009; Ogunbiyi & Goulding, 2013; Rodrigues et al., 2013). Specifying value form the client's perspective and elimination of non-value adding activities from the construction processes were found to be the most ineffective strategies in promoting safety and health using lean construction techniques.

In this study, 80% (35 of the 44) of the interviewees noted that limited knowledge of lean construction techniques as a major challenge in the UAE construction industry. This therefore meant that limited knowledge of lean construction techniques among top managers in the UAE hindered the application of the same techniques in construction. This finding is supported by the study conducted by Ogunbiyi et al. (2013) who also found lack of knowledge as a key challenge among the UK firms. The study found out that only 14.5% of the surveyed firms had above 70% of lean construction techniques and practices on their project. Ogunbiyi et al. (2013) further maintained that the reason for the low percentage was due to the fact that lean construction concept was still new to the UK construction industry. In support, a study by Bashir (2013) in the UK found that limitations in lean knowledge were the third highest reason that was encountered in the implementation of lean construction methods. This finding of the current research is also supported by the findings reported by Lindhard and Wandahl (2014). The latter study revealed a general deficiency of knowledge of lean construction techniques among the surveyed firms. According to Lindhard and Wandahl (2014) 18.8%, 28.1%, and 78.1% did not perceive flow, value creation, and transformation as part of lean construction practices. The study also found that lack of knowledge of lean construction techniques played a significant role in facilitating the partial application of lean construction techniques as opposed to application as a complete system.

In line with compliance, this research found that 75% (33 of the 44) of the interviewees noted that employee non-compliance as a key challenge in the UAE construction industry. This means that the lean construction techniques, according to the 75% of the interviewees, were largely ignored by the construction firms. The non-compliance, according to the findings, may have been caused by the culture of resistance to change, lack of awareness, and adequate knowledge of the lean construction techniques. An in-depth analysis of existing literature conducted by Bashir et al. (2015) examining UK firms and professionals support this finding. The four new challenges revealed by Bashir et al. (2015) included low effort to learn from employees, non-compliance with instructions, lack of incentives and high expectations from the management. This is further highlighted by the study conducted by Bashir (2013) among construction firms in the UK. This therefore means that human and management related challenges are significant in reducing the application of lean construction practices in construction industry. Bashir et al. (2015) therefore maintained that resistance to cultural change, misconception about lean techniques, and lack of cooperation from employees played an important role in impeding the application of lean techniques. Barbosa et al. (2013) also supports this finding in the Middle East context by maintaining that the difficulty in the implementation of lean construction techniques was largely due to employee non-compliance. Employees, according to Barbosa et al. (2013), had difficulty in understanding the new philosophy of planning that further led to non-compliance.

This research also found out that 66% (29 of the 44) of the interviewees noted that the inadequacy of incentives as a major challenge to the implementation of lean construction techniques among UAE construction firms. According to this section of interviewees, the implementation of lean construction techniques was greatly hindered by the lack of adequate incentives. The lack of adequate incentives according to this research may have been propagated by the lack of support and commitment from the top management which in some cases is viewed as an additional expense. Sarhan and Fox (2013) support this finding through a survey conducted in the UK on the lean construction techniques and practices among firms. The study also identified the lack of adequate incentives and motivation as a key barrier to the implementation of lean construction. Sarhan and Fox (2013) further maintained that the implementation of lean construction should be accompanied by adequate funding to facilitate the acquisition of relevant equipment, reward systems and incentives. Bashir (2013) and Bashir et al. (2015) also supports the current study's findings by identifying lack of incentives as a major challenge to the implementation of lean construction techniques. The major reasons brought forward by Sarhan and Fox (2013) and Bashir et al. (2015) for propagating the lack of incentives is lack of top management support and commitment, which is in agreement with the current study's position. Sarhan and Fox (2013) further maintain that, due to lack of management support, lack of motivation and incentives to professionals is experienced. Unwillingness to invest more funds in training workers on lean construction is also experienced from the management. In as much as the reasons brought forward by Sarhan and Fox (2013) and the current study for the non-commitment of managements to facilitate lean construction differ, the point of convergence is the fact that the lack of adequate incentives results from non-commitment of managements.

In this study, 48% (21 of the 44) of the interviewees noted that the lack of government support and inadequacies of lean construction as a key challenge to the implementation of lean construction techniques. The study conducted by Bashir et al. (2015) presents a view by indicating that the role of government is important to the implementation of lean construction techniques. In light of the governments' intervention in the construction industry, Bashir et al. (2015) identified government policy as a key challenge to the implementation of lean construction. According to Bashir et al. (2015) problems related to government policies such as policy inconsistencies and unsteady commodity pricing significantly impedes the implementation of Lean construction in various countries. Jalil et al. (2015) found that the lack of specific regulations to control the stakeholders in the construction industry also contributed significantly to the slow implementation of lean construction.

Locatelli et al. (2013) found out three weaknesses associated with lean construction that impeded the implementation of lean construction and they included associated training costs, challenge to spread the culture, and the need to overcome the initial resistance. In addition, Nesensohn et al. (2013) also found out sustainability of employees, new partners, understanding of lean thinking, increase of planning effort, and willingness to change were the instrumental weaknesses associated with lean construction hence facilitating its inadequacy. According to Nesensohn et al. (2013), planning efforts would be higher and a higher employee fluctuation would also weaken the implementation of lean construction. The introduction of new partners would also bring forward inconsistencies especially considering the existing number of partners required in construction such as architects, contractors and sub-contractors, engineers, and project managers. Workers are also inclined to falling back to the original daily routine which does not poses any lean approaches and techniques (Nesensohn et al. 2013). In order to reduce the impact of the weaknesses of lean construction, a good communication maturity, willingness to change, existence of a process vision, and top managements' commitment are needed in firms for the establishment of the frameworks that would effectiveness of lean techniques.

In summary, lean construction can be useful in reducing- if not eliminating- injuries, death and accidents at the construction site. This study has established the benefits of using lean techniques to promote safety and health in the UAE construction industry. However, it is important for practitioners in the industry to invest their attention and resources in training and increasing the knowledge of all the concerned workers on how to effectively implement lean techniques with the aim of eliminating injuries and accidents. In addition, it is important for construction stakeholders to invest in direct safety strategies including having a clear emergency procedure at the site. Practitioners in the construction industry may also benefit by implementing lean construction techniques comprehensively as opposed to using specific components of this methodology.

The use of qualitative and quantitative research approaches provided an in-depth understanding of how lean construction and health and safety practices interact to reduce fatalities and injuries in the industry. However, future studies can further investigate the causal-effect association between lean construction and safety. It is also interesting to explore how introduction and use of other lean technologies, apart from LPS and visualization, can impact on safety and health practices in the construction industry.

6.4 LOW CARBON STRATEGIES

In this study, 89% (39 of the 44) of the interviewees noted that their organisations have implemented low carbon strategies to promote sustainable construction practices in their organisations. Climate change and rapid population growth had become the harshest problems over the world. For more than a century, human activities have released huge amounts of carbon dioxide and other greenhouse gases into the atmosphere causing changes in temperature, precipitation, or wind patterns, among other effects (Environmental Protection Agency, 2017).

Global greenhouse gas emissions have amplified by 70% between 1970 and 2004, which CO2 was the main contributor. With present climate change mitigation policies and associated sustainable development performs, global GHG emissions will carry on to grow over the next few decades. IPCC SRES scenarios forecast a 25-90% increase of GHG emissions in 2030 comparative to 2000. (IPCC, 2007)

Cutting greenhouse gas emissions to prevent potentially calamitous global climate change involves extensive redevelopment of infrastructure systems. Cities are acknowledged as vital performers for leading the climate change mitigation (OECD, 2008). Cities are the only main contributor to climate change which is accountable for almost 75% of the carbon emissions over the world. Therefore, it is essential that low-carbon infrastructure is integrated into cities to reduce CO2 emissions. (Livingstone, 2007)

Infrastructure is the foundation of the human economy. For instance, in the UK, almost 53 percent of carbon is released directly or indirectly through infrastructure systems. By means of infrastructure, most of the systems will stand for centuries and they are slow to change. For example, some of the highway road systems have been constructed for a thousand years. Most of the infrastructure system that supplies the accommodations and commercial building in the UK is over a hundred years old. Transformation of infrastructure system takes time, the systems cannot be transforming overnight, or even decades. The involvement needs to be quick and smart to make the greatest influences and to make the best changes to reduce the carbon which also results in improved reliability, interdependency and overall resilience. (Green Alliance, 2016)

As stated by Peter Hansford the chief construction advisor to UK government "Infrastructure is created to meet the requirements of the end users. The real question about sustainable infrastructure is: how are we going to meet users' needs in the long-term when everything points towards a resource-constrained future?"

Till a moment ago, the UAE construction industry was not attentive of the primary role in transforming to low carbon. The risk of global climate change will oblige an international response. Cities over the world are accountable for almost 75% of global carbon emissions, hence cooperation between cities and action at the single city level can have a momentous influence on the success of both the mitigation and adaptation to the impacts of climate change. Momentous exertions are being made in cities to provide solutions to solve and address the environmental concerns while supporting economic growth. Nevertheless, this required to be braced by the strong political leadership and actual public action. The businesses have a heavy-duty to give indications in making a transformation to a low-carbon. Similarly, citizens of life in the cities need to be encouraged to accept the low-carbon lifestyles. Policies should focus the wants to provide the essential motivations for business to invest in low-carbon technologies, on the other hand, promote cognizance of the influence of the lifestyles, in that way empowering the crucial shift in behaviour in the cities. (Green Alliance, 2016)

In the UAE, the construction sector is a vigorous section of the overall economy and to deliver a better future development. In addition to the scheduling of momentous investment in infrastructure sector, the government of the UAE is also arranging enormous scale in reducing the CO_2 carbon emissions as a result of the menace from climate change. For instance, in the meantime, the UK had a legitimately requisite commitment to reduce CO_2 emissions by 80% by 2050 from 2008 while the government sanctioned the Paris Agreement on Climate Change in 2016, which intends to restrict the global warming to ‘well below 2°C’in this century (Green Building Council, 2017).

A report from the Infrastructure Carbon Review (ICR) specifies that an 80% reduction in carbon emissions from the UK’s infrastructure sector associates to emissions of 34 $MtCO_2e$ per year in 2050 from a starting point of 157 $MtCO_2e$ per year from 2010. Therefore, it is essential that the infrastructure industry in general reduce carbon emissions from every possible stage including operation, maintenance and decommissioning of the infrastructure assets, over and above for the new infrastructure assets or to modify the existing infrastructure systems (HM Treasury, 2013).

The infrastructure industry in the UAE has just realized the need for this transition. Since then, the UAE infrastructure sector had come along with considerable experience. Clients, consultants, constructors and producers are mounting to the transition, sharing knowledge and developing innovative ideas to deliver a more efficient infrastructure asset within the sector (Green Construction Board, 2015).

The intonation of “reducing carbon reduces cost” has become more ordinary in the midst of providers of UK infrastructure sector since an activity, ran by the UK Green Construction Board, displayed that pursuing to reduce carbon will result in a cheaper cost in the whole life infrastructure rather than just attempting to decrease the cost alone (Carbon Dynamic, 2017). Old-style low carbon thought that construction beforehand only required to control operational carbon emissions, and the energy use had been most reckless. Nonetheless, in 2013 the report Infrastructure carbon review released by the Green Construction Board suggested that three elements within the carbon needed to be changed together: ‘capital carbon’ essential to construct the physical assets (as well as embodied carbon), the ‘operational carbon’ required to operate the assets and the ‘use carbon’ spend by users (Green Alliance, 2016).

Many countries over the world are developing their own infrastructure certification schemes to tackle the carbon emissions. Most of the current certification schemes do not set carbon targets, but prizes projects that can determine the consideration, specification and implementation of low-carbon initiatives. This shows that endeavour to reduce carbon were often obstructed since many in the infrastructure supply chain felt it was others responsibility to make the necessary changes. There was a preparedness to participate, but an unwillingness to lead the change. Regulators play a role in addressing carbon, however, they are not explicit in setting targets for carbon reductions and driving performance. There is also no consistency between sectors. Regulators act an important character in addressing low carbon, nevertheless, the regulators are not clear in setting goals for reducing carbon and driving performance. There is also no consistency within the industry. Thus, the UAE infrastructure sector had to unite together, all organizations including clients, consultant, constructors or producers have their unique role to play, in this important transition to low carbon, sharing knowledge and developing innovative ideas to deliver a more efficient infrastructure asset within the sector.

6.5 SUSTAINABLE PROCUREMENT STRATEGIES

In this study, 84% (37 of the 44) of the interviewees noted that their organisations have implemented sustainable procurement strategies to promote sustainable construction practices in their organisations. Procurement plays a crucial role in improving efficiency with respect to the economic viability of the construction industry and not only plays a crucial part in sustainability but subsequently reduces costs of construction projects (Meehan and Bryde, 2010). The term ‘procurement’ encompasses everything from environment, economic and social elements and this factors are essential to decision making.

In the context of construction and the built environment, procurement can be defined more comprehensively as the various activities and subsequent process that is followed and utilised to either construct, renovate, refurbish or extend a building (Ramus, 2006; JCT, 2015). As most construction clients have little to no experience in such work, this would involve instructing services from many different organisations and companies that have the relevant expertise and skills (Ramus, 2006). As with various important decision making a benefit risk ratio or concept is considered, financial costs and budgets are considered along with other factors which then consequently help to determine an appropriate course of action and ensure an informed decision is made with respect to which strategy and procurement method should be utilised for a particular construction and building project (JCT, 2015). The underlying factors for procurement have been identified as time, quality and cost (CE, 2004).

With a prominent presence on the agenda, there has been a growing interest in sustainable procurement within UAE construction organisations. Sustainable procurement allows organisations to “meet their needs for goods, services, works and utilities in a way that achieves value” and long term benefits (EPOW, 2010). The concept of sustainable procurement underpins the principles of sustainable development ensuring it is beneficial from an organisational perspective, and supports the fundamental social, environmental and economic objectives and is also embedded within supply chains due to corporate social responsibility (Walker, 2012). From a local economy standpoint financial benefits such as cost savings can be achieved, environmental benefits such as reduced carbon emissions and lower energy can be achieved, whilst a more social benefit would result in improved health outcomes (EPOW, 2010). Two key factors prove influential with respect to providing the right environment for sustainable procurement to occur, this is strategy formulation and implementation and the need for it to be embedded within the supply chain of organisations (Meehan and Bryde, 2010).

For instance, the Green Government Commitments (GCG) have been placed under the spotlight following the publication of the 3rd Annual Report (HM, 2015). This report fundamentally analysed the current and proposed situation, evaluated current performance, identified problems and forecasted any likely issues that would arise with respect to the commitments made and the desired targets (HM, 2015). Key achievements were recognised in all areas and further recommendations were put forward and acknowledged which would improve the overall process in the way in which the government procures goods and services in a more sustainable manner (HM, 2015). The following were key learnings and recommendations that were identified from the report: embedding sustainability through policy and strategy; tools and approaches to embed sustainability into procurement processes; evaluating and learning from results of sustainability procurement activities; and centralising contracting and administrative directions (HM, 2015).

Globalisation is influencing sustainable procurement through ensuring companies and organisations acknowledge and implement international legislation and incorporate the key themes throughout the local legislation and policies, thus ensuring more environmentally friendly production and supply chain management procedures and practices (Govindon, 2011; Tang, et al 2012, Thomson and Jackson, 2007).

Although the uptake of sustainable procurement practices in the UAE organisations has shown a trend of a slow incline, recent developments and research have indicated that it has reached an inflection point (Meehan and Bryde, 2012). Evidence points to the majority of sustainable procurement practices implemented by the UAE construction organisations fundamentally being within phase one and a minority being within phase two. It has been documented that there is a lack of a prominent or firm presence of such practices within the UAE construction sector and this could be due to a number of barriers that have been discussed within this review (Meehan and Bryde, 2012).

Ultimately, sustainable procurement practices and strategies need to be incorporated into an organisations' procurement business model and thus sustainable outcomes and the social, environmental and economic targets can subsequently be achieved and met (Meehan and Bryde, 2012; Skanska, 2011). This theory and underlying principles of sustainable procurement need to be translated and subsequently be incorporated in practice, however, there are barriers which are preventing this from occurring (Meehan and Bryde, 2012; Skanska, 2011). Review of research and literature has highlighted various points of concern such as the challenges faced by sustainable procurement research as respondents feel compelled to express positive opinions and impressions on their organisation's activities and practices (Walker, 2012). This is known as 'social desirability bias' and a so-called "pressure to be perceived in a socially acceptable way with regard to sustainability" and this consequently leads to false-positive results and findings as opposed to what is actual reality (Walker, 2012).

6.6 EQUALITY AND DIVERSITY STRATEGIES

In this study, 80% (35 of the 44) of the interviewees noted that their organisations have implemented equality and diversity strategies to promote sustainable construction practices in their organisations. Across the world women face challenges and barriers into the world of construction. Women in the UAE experienced the barrier through cultural obligations. Omair (2010) found that the obligation for an Emirati woman is to look after the interests of her family and leave the career to the man of the house. Emirati women also have added religious connotations. However, even with the cultural and religious factors, women are able to attain higher roles through the government's Nationalisation programmes. Sadly, this came at a price. A woman would be expected to accept a lower salary to do the same job as a man if he was offered the job. Even though the government was actively encouraging companies to employ women, women still experienced those “glass ceiling” restrictions.

Women’s on board (WOB) is an organisation which offers, ‘formation, encouragement and connections to help women get to the top within their own company or to take on a board or committee role as a non-executive director (NED), trustee or governor’ (Womens on Board, 2012). Through these initiatives and organisations, WOB wants to break down the barriers that currently are restricting women getting into these high positions within these companies. Their Ethos is that as ambition and talent are spread amongst both women and men, companies within all areas need to start working towards at a more gender balance at the board, CEO, leader level so that the companies can reach to their greatest potential.

The pipeline was another organisation which was created to deliver an ‘exceptional executive leadership programmes specifically designed for women' (Margaret Mcdough et al, 2017). Similarly, to Women on board, they, have also realised that organisations and companies run better and more successful when there is a bigger diversity of gender at the senior board levels.

According to Gurjao (2014) India has more professionally qualified women in STEM subjects than the USA. This is remarkable in India which is culturally geared towards the favour of men and treating women as second class citizens. For centuries ‘sex-selective abortion’ has run rampant in India causing many female fetuses to be aborted because of their gender (Abrejo et al.2009). In a stark comparison the USA is well known for the ‘American Dream,’ the land of equal opportunity (Rank et al.2014) This dream offered immigrants a chance to build a prosperous life which would not normally be available to them in their country of origin. With that in mind, the assumption would be that the USA would have opened the way to Ethnic Minorities and yet India was leading the way for professionally qualified women. However, the researched examined other countries across the world and found different results.

In Australia an investigation into cultural diversity on construction sites found that site managers do not accommodate for EM workers and even subconsciously encourage cultural divides (Loosemore et al.2010). They found that those workers who could not speak English proficiently or speak English as a second language were automatically mistreated in comparison to those that spoke English as their native tongue. The language barrier created an "us and them" attitude with those from similar ethnicities gravitating towards each other, rather than integrating with others on site. In comparison, the situation in Hong Kong was very similar to Australia. The majority of the workers on construction sites are from South Asian countries and they experience the same mistreatment and harassment.

Wong and Lin (2014) stated that workers were paid less and were not entitled to the same benefits in comparison to the local Chinese workers. They also found that the majority of site based comments identified racial discrimination and bullying which ranged from name calling, racial graffiti, ignorance and social isolation. Ethnic isolation amongst minority groups was a key theme arising from experiences on site i.e. refusing to speak English to those who could not converse in Cantonese. The patterns emerging through these few international studies identified that minorities stuck together and the locals, regardless of their background, discriminated against other minority groups. It was almost ironic how EM's bullied other minority groups. The supposition would be that EM's would coalesce. However, the international research revealed that discrimination exists among any cultural group. So it was not obvious racism such as white and black. Rather, it was an ingrained inclination of “there are more of us than there is of them” which reiterated this “us and them” attitude.

In terms of treatment across the UK, the main factors that affected EM women in construction throughout recent years posed certain similarities to those found internationally. However, there were subtle differences. Loosemore and Higgon (2016) explored the reputation of the construction industry and found that “deep-seated cultural barriers” and an “ingrained stigma” prevented the industry from growing and collaborating with the social enterprise sector. The reputation of the industry appeared to be one reason as to why EM women avoided pursuing a career in the Built Environment. Another issue was the ‘leaky pipeline’ which is a metaphor used to describe how women ‘leak’ from STEMM subjects (Science technology, engineering, maths and medicine) at different stages (Resmini, 2016). The research suggested that the industry lost women for reasons such as discrimination, unfair treatment and raising a family. Those women started at degree level but rarely made it through to completion due to those reasons. This was supported by the evidence contained in the ‘Paula Principle’ produced by Professor Tom Schuller. He wrote about the 5 main factors that affect a woman’s career progression with one factor being psychology (Revesz, 2017).

Brumfiel (2015) also found that psychology was a main factor as to why women leave the Built Environment. Occasionally, a woman’s personal perceptions of her own ability to succeed in these fields prevent her from attaining a career in construction. A woman’s lack of confidence can stifle her when making bolder career choices thus adding to the theory that a woman can literally be her own worst enemy. Another issue was the existence of the ‘old boys club’ stifling diversity in the industry. There was a lack of support for BME SME’s to get onto any Approved Contractor’s Lists. These lists predominantly contain “the more known and larger mainstream companies... ‘favoured’ contractors who are more likely to be white”(Steele and Todd, 2005).

In order to alleviate this barrier, an EM individual or contractor would be expected to abandon their cultural heritage in order to fit in (Caplan and Gilham, 2005). EM professionals were not encouraged to grow in their strengths or on merit. Rather, there appeared to be a process of breaking EM individuals down and rebuilding them so that they fit into this ‘white’ mould. It appeared difficult for EM females to fit in with the ‘white laddish culture.’ A woman may not avidly involve herself in the ‘laddish’ banter and jokes so she could be seen as a social outcast or even racially ‘sensitive’ in the workplace. This leads to EM women being excluded from other generic workplace activities and eventually leaving the Built Environment accepting field or profession. Byrne et al (2005) also found evidence to suggest that EM’s believed that they did not ‘fit in’ on site and were at a disadvantage before they even started work. They felt that the colour of their skin played a major part in how they are treated on site. This created an even bigger issue for EM women who face the potential of both gender bias and racial discrimination.

Another barrier faced by EM women was in regards to their cultural obligations. Ceci et al. (2011) found that EM women who place having and raising children as a high priority are less likely to apply and hold higher ranking positions. However, women who did not possess this desire were noted as applying for just as many higher ranking positions as men. EM women believed that they could not have it all and they had to choose between having children and having a career. In conjunction with this, Chang (2006) identified that historically in EM communities, having children is seen as a cultural obligation. Due to the socio-cultural pressures, EM women felt pressured to leave their careers to have children. The consequence of this is the industry cannot retain the women it employed, thus losing skilled and qualified professionals.

The pattern emerging from the research, both nationally and internationally, was that the construction industry struggles to retain women from all backgrounds, particularly EM women. So not only was recruitment an issue, retention seemed to be a bigger problem. This referred back to the theory behind the ‘leaky pipeline.’ Although, the industry would like to think that there were no ‘leaks,’ the research showed that it was still an on-going issue. The factors that affected women were not only personal. There were also external pressures such as raising a family, cultural stigmas and overall treatment experienced by EM women both in employment and education. So the problems appeared to vary from country to country but seemed to be the same in the construction industry. EM’s facing both cultural and site specific challenges and barriers whilst trying to maintain a successful career in the UAE construction industry.

The researcher explored the facilitators for EM’s in the UK construction industry and found that there are numerous initiatives in place to help and support EM women. The researcher stated the success of the Athena SWAN Charter, the WISE Campaign as well as the other campaigns and events which are specifically aimed at EM women. One initiative which stood out was the 30% club. This was created to diversify board members in the financial sector. Now, a quarter of the FTSE 100 board members are female. This initiative must be tailored so that the Built Environment can benefit from a similar drive to recruit women into senior positions in construction companies.

6.7 WORKFORCE SUSTAINABILITY STRATEGIES

In this study, 73% (32 of the 44) of the interviewees noted that their organisations have implemented workforce sustainability strategies to promote sustainable construction practices in their organisations. The European Research Council (ERC) provides criteria for judging the sustainability of a workforce. Productivity, satisfaction, organisation profitability, employment rate and general economic health are the key metrics that they consider (Sustainable Workforce, 2016). This is a clear indication by a leading commentator that the industry workforce is currently unsustainable. Dainty and Loosemore (2012) describe the construction industry management of people as poorly understood and say that there has been reluctance to having critical discussions of human resource management (HRM) in the industry. They say that the industry is reliant on 'best practice' panaceas which may be an indicator that the industry is reliant on tried and tested traditional practices.

They say that discussion of construction HRM has focused on producing cost efficient performance outcomes; this may be indicative of an industry described by Farmer (2016) as low profit, financially fragile and used to adversarial pricing models. It is likely that a financially insecure industry in survival mode will focus narrowly on cost efficiencies rather than the wider issues of its human resource management practices.

Consider the traditional project time, cost and quality triangle shown to the right. The provision of the industry workforce may largely be focused on minimising costs and time to procure, quality of the workforce is left as a side issue or luxury to these two overriding requirements. If a normal project scope were to be represented this way on the triangle it would likely cause alarm to project management professionals, yet it seems to be an accepted as 'business as usual' in the industry.

Modern changes in social conditions have complicated labour markets by bringing human rights into play. It is no longer acceptable to treat workforces as simple human capital, they must be cared for. Labour is also free to come and go from any given industry so the more difficult or stressful the work in a sector the harder it is to resource.

In the UAE construction industry has been accused of widely treating its workforce as a form of capital to be exploited. Despite its size and importance to the UAE economy it may fail to recognise the need for modern human resource management. Oluwatayo (2014) suggests some major factors for job satisfaction; work interest, autonomous working, acceptable pay and transparent work environments.

Lim and Ling (2012) agree and add reasonable workloads and recognition of work to the list of factors for job satisfaction. They go on to link job satisfaction with employee retention and support the view that workforce satisfaction needs to be managed if an organisation intends to retain its employees. Hussey (1996) supports the link between satisfaction and retention and states that there are “few solutions” in human resource management that can be treated as lone issues. Hussey (1996) examples the complexity of satisfaction by listing various entangled issues such as: business culture, career prospects, communications, training, salaries etc.,

Dainty and Loosemore (2012) point towards a trend for construction project managers to disregard the training and satisfaction of the people they employ because they are self-employed or sub-contractors and thus beyond the remit of the managers consideration. A satisfied workforce is required to retain talent within the industry but the industries own attitude towards its sub-contracted and self-employed labour may provide a significant barrier to implementing better working environments. The industry wishes to remain separated from its workforce to allow divorce at any given time. Farmer (2016) attributed this to the unpredictable economic environment that construction operates in. A sense of ownership and responsibility for the workforce may be missing in the industry which could create an environment of insecurity and ill feeling; it is difficult to foresee a satisfied workforce operating within these conditions.

Lawler (2008) discussed modern talent acquisition and described it as "increasingly complex" and challenging due to the globalisation of workforces and the diversity this brings. There is now a "scarcity of talented people" and so attracting that talent is more difficult than ever. The complexity of modern talent acquisition may be compounded within construction because it suffers from distinctly poor attraction which Farmer (2016) cites as an influencer when informing the career decisions of quality human resources. He says that this is a holistic issue that is the result of the industries other issues combined to create an unattractive image for the industry.

Image may also be affected by the poor promotion of the industry from those within it. As discussed earlier, the industry suffers from poor worker satisfaction and unsatisfied workers are unlikely to promote the industry to those outside of it. Farmer (2016) describes this as a lack of frontline ambassadors that should be promoting the industry to their social networks.

In the USA the American Society of Civil Engineers used an IMAX movie theatre to inspire children to take up Civil Engineering studies. The benefits of infrastructure improvements around the world were case studied and made interesting for the audience. Professional producers and modern techniques were utilised to create an intelligent movie for showing in cinemas in the USA, Canada and Mexico for National Engineers Week in 2017 (Tuchman, 2017). Further USA based inspiration and leadership is documented by Rice (2017a) and details a student programme that planned, implemented and managed sustainable energy production projects in villages in Nepal. Some of the students have gone on to create successful businesses from the projects.

6.8 SMART CITIES STRATEGIES

In this study, 68% (30 of the 44) of the interviewees noted that their organisations have implemented smart cities strategies to promote sustainable construction practices in their organisations. ‘Smart’ is a relatively new term that has been associated with cities, infrastructure, technologies and systems. The British Standards Institute (BSI) provides the following definition: “a smart city is the effective integration of physical, digital and human systems in the built environment to deliver sustainable, prosperous and inclusive future of its citizens” (Capdevila and Zarlenga, 2015). In 2014, the International Telecommunication Union produced a focus group technical report which analysed 116 definitions related to smart cities, and the following definition was the outcome of this analysis: “a smart sustainable city is an innovative city that uses ICTs and other means to improve quality of life, efficiency of urban operation and services and competitiveness, while ensuring that it meets the needs of present and future generations with respect to economic, social and environmental aspects” (International Telecommunication Union, 2014).

This definition was based on four common key attributes for each existing definition that was reviewed and compared from a variety of existing literature on smart cities definitions: sustainability – associated with governance and city infrastructure, climate change, energy, waste, pollution, society, the economy and health; Quality of life – QoL is a recurring theme and aim for smart cities and is focused on two main aspects i.e. emotional and financial well-being; urban aspects – several indicators are included in urban aspects e.g. governance, technology, infrastructure, economics and sustainability; and intelligence or smartness – aspects of smartness include smart people, smart economy, smart governance, smart living, smart environment and smart mobility.

Four core themes were also identified: society, economy, environment and governance (International Telecommunication Union, 2014). Thirty key terms were identified which were classed as having high importance when creating a standardised definition for smart cities e.g. adaptable, resilient, infrastructure, governance, reliable, ICT, safe, economic, security and more (International Telecommunication Union, 2014).

Upon reviewing just a sample of the various definitions of 'smart', it is evident that each distinct definition emphasises a different perspective of what it means to be smart (Dameri, 2016). As such, governments and local authorities (as well as other key stakeholders) should work together to create a more holistic and consistent understanding of what 'smart' truly is i.e. identifying key principles of smart, measuring performance of being smart, does being smart change for different geographical regions or cities etc.(Dameri, 2016).

In modern 21st century cities around the world, there are defined performance targets. However, the assessment tools and methods for measuring these have moved from sustainable assessment to smart city goals (Ahvenniemi, et al., 2017). The terms "smart cities" and "sustainable cities" are often confused, and a hybrid term 'sustainable smart cities' also exists (Ahvenniemi, et al., 2017). There is a greater emphasis on new and emerging technologies and ‘smartness’ for smart city frameworks compared to the sustainable city frameworks.

Another comparison of the two definitions and concepts highlights the fact that smart city frameworks seem not to focus as specifically on environmental indicators in comparison to sustainable city frameworks, leaving relatively more of the attention to social and economic aspects (Ahvenniemi, et al., 2017).

Smart cities are generally described as cities which focus the use of information technology (IT) to manage the services within a city and the infrastructure of that city (Spacey, 2016). It is also closely linked with big data, artificial intelligence (AI), sensing networks, remote monitoring, pervasive computing and algorithms (Spacey, 2016). The focus for smart cities tends to be towards transportation and infrastructure management (in the context of smart infrastructure), whereas for sustainable cities, the focus tends to be on a combination of environmental protection and quality of life for habitants of the city (Spacey, 2016).

The Royal Academy of Engineering initiated a round-table discussion in 2011 of smart infrastructure, in order to determine some of the fundamental aspects of smart infrastructure (RAEng, 2012). From this round-table discussion, the following definition/explanation was deduced: smart infrastructure responds intelligently to changes in its environment, including user demands and other infrastructure, to achieve an improved performance (RAEng, 2012).

Infrastructure is a core element of any development which enhances the quality of life for humans (Samli, 2010). It provides and enables many different functions within cities and more specifically in the context of smart cities, smart infrastructure plays a crucial role (Mills, 2001). Smart cities are multi-faceted entities which include: smart governance, smart mobility, smart law, smart infrastructure and smart people (Lee, 2012). The fundamental characteristic which underpins these various aspects of smart cities is the generation of big data; this data can be used in a smart/intelligent way in order to optimise processes and systems and enable more efficient operations and procedures (Capdevila and Zarlenga, 2015). In order to create smart cities and smart infrastructure, there is a requirement to invest large quantities of capital, as well as the associated operational costs (Capdevila and Zarlenga, 2015). This initial investment and continued operational expense should be outweighed by the returns via cost savings and efficiencies (RAEng, 2012). For any infrastructure development plan, the business plan must be supported with clearly defined designs and associated principles of design (RAEng, 2012).

There are four key principles of smart infrastructure (RAEng, 2012); these are: Data – this is generated in large quantities by smart infrastructure, which is then used within smart technology. The ownership of smart data is of vital importance, allowing users to determine how it can be translated into information, then into knowledge and finally into value (RAEng, 2012). Analysis – the development and formation of new decision support tools, based on mathematical modelling of carefully selected data sets and information. The aim of these decision support tools would be to provide information that is more reliable; this will aid the decisions made by public and private sector organisations and businesses. This requires new systems to be created and potentially standards for quality control and assurance (RAEng, 2012). Feedback – a system becomes smart when a feedback loop is used to improve the operational use of infrastructure assets, based on information obtained on the assets use. Adaptability –

smart infrastructure systems that have the ability to adapt to new and emerging technologies, as well as future needs. These systems do not require large-scale redevelopment to integrate new technologies, saving on costs and reducing the replacement of existing systems and their components. The systems can also adapt to changes in use and variances in demands (RAEng, 2012). The United Nations (2014) also developed several principles of smart infrastructure design: people centred and inclusive; resilient and sustainable; interoperable and flexible; and risk-mitigating and safe.

6.9 BUILDING INFORMATION MODELLING STRATEGIES

In this study, 61% (27 of the 44) of the interviewees noted that their organisations have implemented Building Information Modelling strategies to promote sustainable construction practices in their organisations. Adopting the use of BIM within the construction industry will depend on how the industry recognises the benefits. Companies who intend to implement BIM will need to be influenced by factual data. Investing in BIM is of importance to establish the level of cost, training requirements and time associated for implementation (Lu, *et al*, 2013). Traditional designs with the production of 2D drawings often requires designers to stop and review schemes to ensure designs are correct, alternatively designers will focus on designing projects by using 3D methods. Using 3D designs will be easier to visualise, understand and implement, producing ‘what you see is what you get’ designs. Creating the digital visualisation in a virtual environment, errors can be easily identified and amended before generating construction rework. This benefit is due to the visualisation format 3D modelling offers (Lu, *et al*, 2013).

Construction plans can be produced from a 3D model, these plans can be reviewed and then the ideal choice can be chosen, this is before construction work takes place. Safety onsite is of paramount importance and vision for all construction industries, by utilising the 3D model, unsafe areas can be efficiently identified at design stage. This is achieved by virtually walking on the worksite within the 3D model, traditional 2D drawings will take time and adequate knowledge from a designer/engineer to establish the risks involved, but with 3D modelling this work is simplified and increases productivity (Lan, et al, 2015).

Lack of communication within projects often lead to delays, costs exceeding the agreed budget and poor quality. Therefore, communication is essential to any given project. Implementing BIM develops a vast improvement to this area uniting the different disciplines, sharing construction procedures and available resources. Utilising BIM on a project will enhance the communication chain throughout the lifecycle of a project, developing information and knowledge which is extremely beneficial to the success of delivering a project on-time and within budget. BIM provides a consistent platform for disciplines to manage and share their knowledge and information (Lu, et al, 2013).

BIM is the essential component when developing Smart Cities, as previously mentioned BIM is not just software; BIM signifies a change from traditional processes. However, these processes are assisted by software, increasing performance which becomes the principle support for the creation of Smart Cities (Andrews, 2014).

Infrastructure within the transportation sector consists of many disciplines, considering the project life-cycle of any infrastructure project can identify many teams. These teams will manage planning, design, construction and maintenance. Applying traditional project management methods will witness loss of communication at each discipline handover; some of the knowledge will be lost. Implementing BIM will significantly reduce breakdown in communication, BIM will remove obstacles by applying a set of standards and operations all must work from enabling constant knowledge improvement of the project which is recorded at all stages for everyone to see. Smart Cities are knowledge databases that have greater potential than any of our traditional predecessors, the ability to be twenty-four-seven in real time will benefit all (Andrews, 2014).

Benefits of smart cities include; reduction of energy consumption, smart bins which alert the authorities when full, smart sensors in water networks to identify leakages, smart sensors for lighting which only illuminate when activated by users, public transport information available at any time in real time, road networks giving priority to emergency vehicles, intelligent transport systems with variable speed restrictions which will alleviate traffic congestion reducing CO_2 emissions. These examples are only a few of the smart city capabilities, many more will be developed (Westgate and Jones, 2017).

Cities worldwide are the main contributor towards climate change, covering less than 2% of the Earth's surface but consuming 78% of the worlds energy which contributes 60% of all CO_2 emissions. Managing, improving and reducing the demand will develop a sustainable future for all to benefit (UNHabitat, 2015).

6.10 SMART TECHNOLOGIES STRATEGIES

In this study, 52% (23 of the 44) of the interviewees noted that their organisations have implemented smart technologies strategies to promote sustainable construction practices in their organisations. In this generation we hear a fair lot about smart cities, smart motorway, smart production and so on, these ideas all rooted form industry 4.0 following the trend that is digitalisation and increasing the use of ICT within the manufacturing environment. Industry 4.0 contains a wide range of technologies that can aid in the roll out of the digitalisation and automation of the construction industry. This new era of the digital world is expected to improve quality and decrease time while saving costs and improving performance (Marr, 2018). With all these benefits, most of the construction infrastructure sector have yet to fully manage and integrate these technologies to keep up with other sectors such as automotive and mechanical who are advanced with innovative technologies (Marr, 2018).

Industry 4.0 is still at its early stages when it comes to the construction infrastructure sector (Barrow, 2018), over the past twenty years, there have been numerous technologies such as the Building Information Model (BIM) which has been adopted by most construction companies in charge of public sector projects, BIM has given the different disciplines in organisations a different outlook on how to improve construction at all stages (Barrow, 2018). Based on a survey in 2017, 67% of UK manufactures are aware that Industry 4.0 can provide benefits and opportunities, however only 25% feel that they understand these opportunities (Maciver, 2017), judging by the results there is a need for more research to be conducted on industry 4.0.

The industrial production is being transformed by technologies, and these digital technologies are being currently used in manufacturing and if fully adopted by the construction sector can lead to better efficiency and enhance relationships between all disciplines in an organisation (Boston Consulting Group, 2018). There are nine main technology trends which are included in Industry 4.0 transforming the UAE construction production as cited by interviewees includes: Big Data Analysis - in the construction industry, data is a crucial aspect as when the project is completed, asset management goes on and the more data collected in the construction stage the more the asset can be maintained in an efficient manner. With Industry 4.0, the technologies produced are equipped and with the use of a successful IoT (Internet of Things), data accumulation and analysis obtained from technologies can enhance cross-system interoperation (Loshin, 2018).

Autonomous Robots - Autonomous robots were introduced into the technologies and eventually robots will start interacting with each other and collaborate safely with humans working alongside each other. Robots would cost less as labour costs will reduce and the robots would hold a greater range of skills and abilities (Boston Consulting Group, 2018).

Simulation - With 3D modelling and BIM, simulations are being used more in the construction infrastructure sector. Creating these simulations allow real-time data to mirror the virtual model created which can also include machinery and humans. With machine simulations, operatives can test products virtually before the machinery is physically changed enabling less machine set up time and increasing quality (Boston Consulting Group, 2018). Simulations in the form of 4D sequencing is also a useful tool as site teams can visualise the planners programme and understand the scope of works.

Horizontal and vertical system integration - Implementing Industry 4.0 allows companies, departments and functions to become unified. Data integration networks then can evolve, and value chains can become fully automated.

The industrial IoT - The concept of Industry 4.0 is based on more devices being enhanced, this will then allow field devices to link and interact with each other. This aspect will allow real-time responses and decisions to be made.

Cybersecurity - With the change to Industry 4.0, communications and sensitive information are to be stored in a database to increase connectivity. Due to all documents being in a database, security of machines and software is critical.

The cloud - Data sharing is a necessity when it comes to the construction industry as there are different disciplines in one organisation. Sharing data through means of emails usb's etc can be a risky one as the information shared may not be up to date or information can be lost in transition. Industry 4.0 is to improve the performance of cloud technologies and data can be shared in milliseconds and with a cloud database, unlimited storage space for information can be possible.

Additive manufacturing - Additive manufacturing such as 3D printing is only at its prime stages, companies mainly use these to create prototypes of works creating the individual items. In the future, Industry 4.0 allows additive-manufacturing to be implemented and used widely to manufacture construction products such as lightweight designs which are complex (Boston Consulting Group, 2018).

Augmented Reality - Augmented reality is an interactive experience where real life world is generated by a computer, currently, augmented reality has taken over the gaming industry and within the construction industry it is in its infancy however in the future a wider use of augmented reality will provide the construction industry with real time information and improve the decision making within planning periods (Chandler, 2018). Internet of Things (IoT) Focus to deliver efficient system and accurate automation to the users IoT also provides an advanced system analysis and its integration to offer the latest technology with accuracy. The internet of things also works with the ultimatum technology system in the field of robotics, network, and sensing. The internet of Things takes advantage of using the latest technology in the software area which has become cheaper over the years but also with an innovative system. The features in the internet of things are up to date to enhance the performance and give an advanced technology.

6.11 SUMMARY

The defining characteristic of the successful 21st Century construction organisation will be its ability to embed sustainability in every fiber of its operations. Therefore, the UAE Government is encouraging the implementation of sustainability programmes. However, the extent to which the UAE construction sector embrace sustainability issues as an integral pillar of their business models remains unclear and poorly investigated. Sustainability is about building a society in which a proper balance is created between economic, social and environmental objectives. Sustainability is all about integrated thinking – opportunities, interconnections, risks, solutions, impacts. It improves efficiency, productivity and value. It supports and enhances the governance systems most organizations already have in place. The organizations that have used it to strengthen their businesses have aligned their values, mission and goals with sustainability.

This chapter discussed the nine key sustainability initiatives that have been implemented in the UAE construction organisations. In the order of implementation, they are: waste minimization strategies, lean construction techniques to promote Health and Safety practices, low carbon strategies, sustainable procurement strategies, equality and diversity strategies, workforce sustainability strategies, smart cities strategies, building information modelling and smart technologies strategies. Overall, the following inferences and implications could be drawn:

- Overall, the outlook for improved sustainability initiatives efforts from the UAE construction organisations looks quite promising at present. This is because organisations those implement sustainability initiatives will benefit from improved reputation, better employee engagement, lower operating costs, and better relationship with key stakeholders. Clear and strong brand, should improve the public perception of the quality of services that construction firm offers, and this in turn, will increase the trust, loyalty and will help reducing the perceived risk.

- The current study results suggest that the implementation of smart technologies initiatives to deal with sustainability initiatives is still evolving in the UAE construction organisations. Taken together, the impact of leadership, sustainability-related policies, structures, reward systems, training programmes and performance reporting are key factors in successful implementation of sustainability initiatives. It is suggests that more clarity is needed on how the UAE construction organisations must change to meet the sustainability challenge, and how the necessary changes may be achieved. Therefore, there is a need for cross-sector collaboration to capture and share best and worst practices related to implementing smart technologies.

- The construction industry is currently in a new era, industry 4.0 has been introduced which relates to utilising technologies in the construction industry to improve quality, save time and cost and improve construction practices. There are many technologies which are involved with Industry 4.0, and few companies in the UAE have already adopted some of the technologies. These technologies include virtual reality, augmented reality, BIM, just to name a few. Based on the findings from the research, most projects have adopted a variety of technology, mainly BIM as it has been mandated in the UAE. Other technologies such as Virtual Reality is being used for benefits such as allowing companies to demonstrate the future final product to the public and improve decision making within the project teams.

- Most of the technologies included in Industry 4.0 are still at their infancies and for the future would recommend more research to be carried out on these technologies, this will enable the construction industry to understand the benefits that can be gained from these technologies and with the industry being known for resisting change, demonstrating these benefits can be the start of the construction industry embracing the change.

- The scarcity of knowledge and expertise associated with sustainability initiatives is, and will continue to be, a huge challenge for the UAE construction organisations. Therefore, training programmes related to the management of sustainability-related knowledge will help leaders, managers, and change agents to better understand on how to craft and implement various sustainability-related strategies for competitive advantage.

- Associated economic, social and environmental impacts population growth and the resulting pressure on the limited resource the planet can offer have encouraged the UAE organisations to find new and more sustainable ways to operate. As a consequence organisations are required to ensure that their operations create positive impact on the environment and society. Furthermore, organisations are increasingly recognizing opportunities for profitability from the adoption of business models that address sustainability challenges.

- By innovating their business models organisations have become better capable of creating positive social and environmental change by redefining the purpose of the organisation, developing mutually beneficial relationship with stakeholders or by increasingly interacting with the market as they seek for legitimacy throughout institutions and market they operate. Ideally a sustainable business model is one that contributes to sustainable development while ensuring competitive advantage by delivering greater forms of value to customers.

- It is concluded that sustainability issues are complex, dynamic, and multifaceted. Most of the sustainability initiatives are inherently collaborative, as they relate to supporting the community and future generations. Therefore, to solve some of the global sustainability problems, it is important that key leaders and decision makers connect with other stakeholders to have a positive social impact.

- In current business environment, traditional product innovation is not enough to ensure an organisation sustainable competitive advantage. To achieve that, organizations must value new methods of value creation. Business model innovation allows the delivery of novel value proposition to consumers by the transformation of the value creation, delivery and capture mechanisms. However, there are scenarios where business model innovation fails mainly when organisations fail to meet the defined goals for the process and to align functional parts of the organisation to deliver the desired outcome.

The Chapter 6 has addressed the third research objective, which is “to investigate and document the key sustainability initiatives needed to effect change that are currently being implemented in the UAE construction organisations” and third research question, which is “what are the key sustainability initiatives currently being implemented in the UAE construction organisations needed to effect change” of this study. The next Chapter (Chapter 7) will discuss on the key challenges the UAE construction organisations face in implementing sustainability initiatives.

CHAPTER 7 : THE KEY CHALLENGES OF IMPLEMENTING SUSTAINABILITY STRATEGIES

7.1 INTRODUCTION

This chapter discusses on the key challenges the UAE construction organisations face in implementing sustainability initiatives. The results are based on the perception of the 44 participated interviewees. The findings are also substantiated with the relevant literature. In this study, during face-to-face interviews, interviewees were asked about key challenges their organisation face in implementing sustainability initiatives. Table 7.1 presents four challenges the UAE construction organisations face in implementing sustainability initiatives. Each of these key challenges is discussed in details from section 7.2 to 7.5. Finally, section 7.6 summarises the key findings. In doing so, this chapter addresses the fourth research objective, which is "to critically appraise and document the main challenges the UAE construction organisations face in implementing sustainability initiatives" and fourth research question, which is "what key challenges do UAE construction organisations face in implementing sustainability initiatives".

Table 7.1: Challenges for implementing sustainability strategies in the UAE construction organisations (N=44)

Sl. No	Challenges	Total number of interviewees cited (N=44)
1	Skills of a sustainable construction workforce	70% (31/44)
2	Low priority	64% (28/44)
3	Cost	57% (25/44)
4	Lack of awareness	45% (20/44)

7.2 SKILLS OF A SUSTAINABLE CONSTRUCTION WORKFORCE

The most common challenge facing the implementation of sustainable strategies as indicated by the interviewees' in this study was skills of a sustainable construction workforce (70%). The UAE construction industry is heavily reliant on traditional skills and suffers consistent shortages. The Royal Institute of Chartered Surveyors (RICS) reported in November 2017 that 62% of businesses were reporting stymied growth due to a shortage of available skills; in 2012 the outcome of the same survey was an average of 40% (RICS, 2017). These statistics point towards a significant worsening of the situation over a relatively short period. The Construction Industry Training Board (CITB, 2016) reinforces the RICS findings and quote positions in the industry as hard to fill: 21% in 2011; 36% in 2014; and 47% in 2016.

CITB state that the cause of the recruitment difficulty is 88% attributable to a lack of the necessary skills in those that are available for recruitment (CITB, 2016). RICS reports the shortages most acute for professional skills with up to 64% of businesses reporting difficulty filling positions; 44% reported the same problem for trade related roles (RICS, 2017).

Khayyat and Lee (2014) discussed the shift in economies of developed countries like the UK and suggest that the increase in technological knowledge is causing a rise in the demand for upskilled labour and a decrease in the demand for low skilled labour. They say that at all levels there is an increasingly higher requirement for technological knowledge. This may be a significant contributor to current skills scarcities as human resources are adapting to the requirements of digitalising global economies.

The National Infrastructure Plan for Skills 2015 reported that the construction industry would need to fill 100,000 new skilled positions by 2020 to deliver the infrastructure projects already in the pipeline at that time. They also cite a figure of 250,000 workers that will need to be retained and upskilled to deliver the UK investment plan over the next decade (HM Treasury, 2015). The industry actually doubled that target and employed around 200,000 more people between 2018 and the reports publication in 2015 (Rhodes, 2018) but the skills scarcity reportedly deepened rather than resolved. That may be because the skills required to address the demand are more closely associated with the future operating environment rather than the traditional. The large numbers of new people being employed in the industry may not possess the skills the industry actually requires.

Furthermore, the UAE construction industry is adapting to operate within the digitalised economy of the modern world. This is in response to industry 3.0, the third industrial revolution, and the technologies it has made available. New processes like Building Information Modelling (BIM) are driving the industry towards full digitalisation. Tools enabled by processes like BIM enable the easier incorporation of machines and automation into construction and may also aid the industries adoption of off-site fabrication processes. The skills required for these changes to the industry are different to traditional construction skills and present a significant challenge in meeting future workforce needs. Digitalisation isn’t only applicable to the construction industry and the skills required within digitalised operating environments may be more portable than traditional construction skills and so the talent pool is smaller because it is shared amongst a wider selection of industries. Gay (2017) states that this digital revolution is changing all economies and societies and is itself a powerful driver of growth. That growth is driving an increase in demand for digital skills and as the demand for traditional construction practices will likely diminish in the digital economy, the demand for new portable digital skills will likely increase.

Gelder (2010) discussed the changes in society, such as globalisation, that are making operational environments more complex. He says that such big changes in Information Technology (IT) haven't occurred since the renaissance. He says that we are now obliged to use computer-based technologies and as these technologies become more and more important, former traditional skills are becoming of less use to us. He describes digitalisation as an "IT-driven spiral" to substantial automation. The more of these technologies we use, the more we need, the more powerful and useful they become.

7.3 LOW PRIORITY

In this study, 64% (28 of the 44) of the interviewees noted that low priority was the challenge for implementing sustainability strategies in their organisations. As sustainable development is emphasised highly within the industry through industry standards and legislation, it may seem contrary that it may be viewed as a low priority by the interviewees.

Shown throughout the results is the dependence sustainability has towards the economic side, while having a high percentage emphasising the economic factor, cost reduction being identified as a key driver and costing as a key obstacle. As previously discussed finance is a critical issue for the construction industry illustrated by the decline following the great recession. A quote obtained from an interview displays this:

> "In the construction industry the main constraints are time and money especially in the rail department, it is very time driven. Sustainability or using efficient materials is very low on the agenda. The main agenda is trying to get something you know will work, in a safe manner and within the time period."

This illustrates how in the case of this interviewee sustainability is an afterthought where the key priority is saving money and time. This is not more so a criticism or problem with sustainability just with an increased environmental emphasis towards sustainability, along with the time taken to utilise sustainable plans.

Having sustainable development as a low priority within an organisation may not be unexpected as there has been accusations of being a justification of cosmetic environmentalism (Robinson, 2004). However as seen by Friedman (1970), Kanugo and Conger (1993) and Carrol (1989) the main principles of business are to focus on margins and ensuring profitability. This attitude where the financial aspect is highlighted over and above all other factors leading to a disinterest is seen following statement on sustainability:

> "The industry isn't interested in the experts who are peddling sustainable development anymore to be honest. The industry is interested in finding the cheapest cost for the house and there has been a pretty big change in the way things have been done since 2010."

The interviewee remarked on how matters have changed since 2010 where sustainability although part of the mainstream was an unknown to many organisations. Here the interviewee has highlighted that the potential he thought could be obtained from sustainable development was not applicable.

7.4 COST

In this study, 57% (25 of the 44) of the interviewees noted that cost was the challenge for implementing sustainability strategies in their organisations. There are some of the misconceptions like a higher cost would be incurred if this kind of development is undertaken and it will be without contributing to the market value of the project. It is highly important therefore to understand and analyse the cost in capital for the sustainable buildings in comparison with the cost of traditional buildings and to identify the worth of these buildings.

It is also critical to highlight the carbon emission between the traditional construction and sustainable construction to show the increase in efficiency and reduction in the cost. The construction industry as already stated is responsible for almost 50 % of the CO_2 emission and extraction of surface minerals of about 90% and 25% waste that is given into the landfills. Even after all these challenges, the construction that focuses on sustainability can be of advantage strategically to the client.

Another important challenge is the cost of sustainable construction, which seems to be quite high now but it will reap future benefits by reducing the cost of maintenance and improving the efficiency of the building as well as bringing down the cost of utility. It is observed that generally the requirements that are assumed to be of a higher cost are miss-interpreted by the client and is of a lower value. One of such example is of urban drainage that was built under the sustainability scheme and has shown savings and is evident that it has reduced cost of the drainage and pipes (Halliday, 2008). There are various other benefits such as energy saving, water saving and downsizing of the mechanical equipment.

7.5 LACK OF AWARENESS

In this study, 45% (20 of the 44) of the interviewees noted that lack of awareness on sustainability was the challenge for implementing sustainability strategies in their organisations. This attitude where the lack of awareness is seen from the following statements on sustainability:

> "Consciousness among employees about sustainable practices, there is an educational barrier in this manner and our company is increasingly working in developing awareness".

> "To train and make employees self-conscious of the everyday tasks that affect the environment are as important as big steps the company might take".

> "Lack of knowledge by all employees and employer. Low education of the labor workforce".

Laszlo and Zhexembayeva (2011) explain how the lack of awareness on the subject, and the constant failure when trying to pursue these strategies has resulted in a pattern among many organizations in which organization remain with the traditional approaches as an answer to alleviate the existing pressures and only embed general strategies as a way of merely serving the corporate social responsibility. It is stated by Du Plessis

(2002) that one of the biggest challenges that sustainability faces is the lack of education. Ignorance and lack of information towards certain subjects has resulted in a state of fear throughout many organizations. In most cases, sustainable strategies are not often seen as a business strategy because of the lack of information obtained by managers, resulting in a business that merely competes on economic levels and can be easily moved from their market position by a new business with new strategies. Many organisations incur in the fear of change and remain with traditional business strategies in order to remain in the market. It can be clearly seen how some organizations do not know what sustainability is and what it means to them in terms of business.

Comberg et al. 2014 explains for the case of new organisations, that leader's role cause business model change as a result of analysing things that are wrong with the current business model; therefore, their leadership is influential to this change and they are responsible of the process. To successfully take advantage of leadership it needs to be align with organisational culture, employee commitment and skills (Neri et al., 2018; Savic et al., 2016).

Sosna et al., (2010) and Chesbrough (2010) argues that past experiences have the potential to define the way organisations adapt to environmental changes which imply that ambiguity in the cognition of leaders within the organisations influence the outcome of business model innovation activities. Adaptation process to the surroundings have driven leaders in organisations to pursue business model innovation as a mean to renovate focus, specialisation and to take advantage of new market opportunities (Bashir and Verma, 2017).

7.6 SUMMARY

The interviewees noted a number of obstacles in the prevention of sustainable development, the constraints went against the aspects of competitive advantage which were high costs of implementing measures and inflexibility countering the holistic viewpoint which sustainability seeks to develop. High costs go against the eco-efficiency outlook attached to sustainable development. High costing seems being prevalent in the data seems to be contrary to the fact cost reduction was the highest emphasised driver for sustainable measures. In order to understand this it is important to remember that legislation also serves as a driver towards the implementation sustainability. DCLG (2012) details the objective to have all homes carbon neutral by 2016 where energy methods have to be implemented however not all energy saving methods are seen as the most cost effective of saving energy such as heat pumps with high expenses (Valizade, 2013). This was remarked by an interviewee where he had claimed the government where pushing towards less cost effective methods of lowering energy. This leads towards the obstacle of inflexibility present within the implementation of sustainability. The sustainable measures are deemed inflexible and inefficient and once again legislation is contributing towards this problem due to excessive regulations from the local government, causing inefficient and costly implementation.

As demonstrated earlier legislation can be a driver for both sustainability and competitive advantage however it must be utilised effectively, or can contribute towards problems as seen in the case of the costing and inflexibility constraints. This demonstrates how certain employees have felt they have suffered from ineffective bureaucracy something that is highlighted and confirmed by the government. However the data illustrates how there is still work to be done where improvements can be made.

Not only has the legislation at times been inflexible but also have some of the sustainable measures such as alternative energy supplies. Alternative energy is something that has been noted as ineffective through the expenses associated with things like heat pumps and solar panels, which have detailed as causing complications and leading towards inefficiencies.

The component of competitive advantage that is at odds with sustainable development is prevention of imitation. Although all organisations would have nuances in their approaches to sustainable development this competitive advantage is lost once a competitor gains to ability to match or exceed the outcomes attained from an organisation's sustainable measures. If the trends continue and at one stage all developments are carbon neutral, environmental and social risks are removed there would be focus towards improving environment and society. However a second or third order fit as highlighted by Porter (2008) where a holistic outlook is developed into the employees would be more likely to work towards more effective sustainable measures. Illustrating that the holistic outlook attained from integrating sustainability would be difficult to be imitated.

It is crucial to ascertain the flexibility of sustainability in a strategic business outlook, which has been done through determining its relationship alongside competitive advantage. This expands on the understanding of sustainability from primarily a morally responsible course of action towards a credible method of creating value for organisations within the AEC industry. Sustainability is looking to become institutionalised and this study demonstrates the potential towards serving the organisations while serving and benefiting society and the environment.

The Chapter 7 has addressed the fourth research objective, which is “to critically appraise and document the main challenges the UAE construction organisations face in implementing sustainability initiatives” and fourth research question, which is “what key challenges do UAE construction organisations face in implementing sustainability initiatives” of this study. The next Chapter (Chapter 8) will present the implementation of key green Building Information Modelling (BIM) strategies in the UAE construction organisations.

CHAPTER 8 : IMPLEMENTATION OF GREEN BUILDING INFORMATION MODELLING STRATEGIES

8.1 INTRODUCTION

The purpose of this Chapter is to present the implementation of key green Building Information Modelling (BIM) strategies in the UAE construction organisations. The results are based on the perception of the 44 participated interviewees. The findings are also substantiated with the relevant literature. In this study, interviewees were asked to describe key drivers, sustainable features, challenges and impact of green BIM in their organisation through face-to-face interviews. Each of these key dimensions is discussed in details from section 8.2 to 8.5. Finally, section 8.6 summarises the key findings. In doing so, Chapter 8 addresses the fifth research objective, which is “to critically analyse the implementation of green Building Information Modelling (BIM) strategies in achieving the sustainability goals of the UAE construction organisations” and fifth research question, which is “what are the key green BIM strategies currently being implemented in in achieving the sustainability goals of the UAE construction organisations” of this study.

8.2 KEY DRIVERS FOR IMPLEMENTING GREEN BIM IN THE UAE CONSTRUCTION INDUSTRY

In this study, interviewees were asked to describe key drivers for implementing green BIM strategies in their organisation through face-to-face interviews. The study results revealed that key drivers have been related to competitiveness and client requirements. The UAE construction industry is competitive and offering BIM provides aspiration to be market leaders between organisations. Some companies are technology orientated and early adopters of implementing green BIM, this allows them to stay ahead of the other competitors who are perhaps lagging in the technological ability. This could be related to business goals rather than technological goals. Clients are progressively making green BIM a requirement, not adopting this will result in business's falling behind.

Utilising green BIM assists designers and clients to visualise elements or the entirety of a project. 3D models offer a walk through digital visualisation which gives the users an improved decision making process and can reduce changes later in the project lifecycle. The ability of acquiring new tools such as clash detection will benefit any given project, this enables designers to check sustainable drainage infrastructure and other services which may exist allowing engineers to design these out at early stages, compared to traditional methods where this could easily be overlooked and not found until construction stage. This ability alone could achieve a colossal saving on any major project.

Another stated driver for implementing green BIM into the UAE construction industry is mainly driven by the reduction of cost, improving delivery times and lowering the carbon footprint associated with projects. Some of the stated drivers for implementing green BIM include: Design drivers – It is important to understand the project requirements; can the design, quality of build, and programme be achieved within the required cost and time budget. Discovering at an early design stage if the project will be notably over budget, rather than after considerate time and effort wasted and by using a 3D Model associated with a cost-database will be of immense value and support. Furthermore, creating a concept model before producing a detailed version allows for a comprehensive assessment of the proposed project to assist if it meets the functional and sustainable requirements. Preliminary designs using analysis and simulation tools increase the quality of the project. Integrated Project Delivery (IPD) is used for delivering project procurement. Green BIM can be employed from the start of the project to enhance the understanding of requirements and to output costs from the evolving design. This enables a better understanding of the costs involved and reduces the delays in receiving hard copies when processing payments.

During any stage of the design process green BIM is capable of extracting an accurate bill of quantities. Throughout the design process it is possible to keep all disciplines aware of the cost implications before the design advances to the detail necessary for construction bids. At the final stage of a design, an accurate estimation based on the quantifiable objects within the 3D model permits the production of a more accurate final estimate. This results in making improved informed decisions relating to cost by using green BIM rather than the traditional paper-based system.

During the construction drivers include: design changes can be entered into the 3D model and revisions to other objects will automatically update. The result of a design change can be accurately displayed and changes can be resolved more quickly. Cross-system updates can be used to achieve clash detections. The source for all 3D and 2D CAD drawings is achieved by the 3D Model, a result from this is design errors caused by traditional inconsistent 2D drawings becoming omitted. Clashes are identified before they are detected onsite, this will increase the construction process, reducing cost, reduces legal disputes and provides a straightforward process for everyone involved in the project. Furthermore, BIM enables the platform where construction planning can be assigned to the 3D model allowing a simulation of the construction process, displaying how the project site will look at any given moment in time. This visualisation provides an accurate insight to how the construction works will look day-by-day, identifying potential improvements along the way. Added benefits will include links from the 3D model to schedule activities and these then being displayed in a construction plan.

Post-construction drivers include: throughout the construction process, the contractor and sub-contractors collect all the information relating to the installed components along with the maintenance records. This information is associated with the objects in the created 3D model giving the owners access to use this in their management programmes. At this stage the information from the 3D model can confirm that the systems are working as designed before the project is handed over. Green BIM at this stage of the project is the origin of information, displaying graphical images and produce the specifications for all the processes used in the project. Analysis of components and operations used can be given to the owner, confirming the design decisions and systems are working correctly after the project is completed. The management and operations of the as-built project will start with the 3D model which has captured all revisions during construction. The model will maintain the processes for real-time control systems, providing an interface for sensors and remote operating management systems. These capabilities are not yet accessible, by using green BIM this will enable a great platform for the use of these added benefits.

8.3 THE KEY SUSTAINABILITY FEATURES WHICH WERE INCORPORATED INTO THE BIM IMPLEMENTED PROJECTS

In this study, interviewees were asked to describe key sustainability features which were incorporated into the BIM implemented projects through face-to-face interviews. In recent years the UAE construction industry focused on using BIM, this reflects back to many benefits and material savings throughout construction stages of new buildings. Many industries started this process by developing integrated analysis tools such as computer-aided design (CAD) and this became the basic concept of BIM process (Volk, et al, 2013). It has been quite some time now, interest of buildings comply with philosophies of sustainability is growing. In this case sustainable term is understood as controlling the construction impact on the natural environment from the very initial stages of the design to the completion time or in other word throughout project lifecycle. This development can also be witnessed in Poland, which is shown by current results of market research and surveys regarding awareness of sustainable building (Sliczna, 2011). In order for buildings to meet sustainability criteria there are other factors needs to be considered such as energy savings and good indoor air quality (Araszkiewicz, 2016).

In this study, interviewees noted that their organisations have implemented green BIM strategies into their projects. For instance one of the interviewees noted that their organisation had embedded sustainable approach to their project not only in environmental conservation and operational savings, but also in built environment including: Green roof: an essential part to achieve the fundamental goals of the building. The purpose of the green roof is to deflect light and heat to provide a natural cooling system for the facility; The building was built with recycled and renewable materials, and during its operation reduce the amount of water and electricity; Special features were integrated to the design with the aim to enhance a healing environment like waiting areas to have access to fresh air and two-story courtyards on each floor to bring the calming power of nature to patients and families; Daylight, views and access outdoors to contribute to human well-being and improve health; Natural spaces to reduce the stress and take advantage of its healing powers; Flexibility to accommodate future changes in the delivery of care will reduce demolition and construction waste; High-efficiency HVAC systems, and low flow plumbing fixtures; and right glass selection to reduce the air changes necessary for comfort to the minimum required for ventilation.

Another interviewees noted that their organisation had embedded sustainable approach to their project including: office and administration spaces facing onto an external courtyard to promote natural ventilation and controlled daylight penetration; natural light to all usable spaces to reduce lighting loads; energy efficient lighting throughout; use of construction materials with a very low environmental impact and use of recycled aggregates; responsibly sourced thermal insulation with a low embodied impact relative to its thermal properties, specified to optimise energy demand and heat recovery; rainwater harvesting from large data hall roofs to provide water for toilet flushing; extensive site waste management plan (SWMP) covering several projects on the campus; substantial enhancement of the ecological value of the site; and an ‘A’ rated Energy Performance Certificate (EPC).

Similarly, another interviewees noted that their organisation had embedded sustainable approach to their project including: a double skinned façade to create a thermal buffer zone to minimise heat gain; a spiralling nature of the outer façade to minimise daylighting and views whilst reduce wind loads and conserve construction materials; its own wind farm and geothermal system, to save energy; rainwater recovery and grey water recycling, to reduce water usage; and an outer wall curtain to minimise light pollution.

Another interviewees noted that some of the key sustainability features integrated into their projects include: naturally-ventilated glass façade was designed to optimise occupant amenity; optimum daylight entry and solar control, reducing the need for artificial lighting; reduced heat loads, helping keep energy consumption in a minimum; incorporation of an innovative hybrid tri-generation arrangement that uses gas and solar energy to generate cooling, heating and electricity; solar panels to provide free cooling for the building; the use of environmentally-preferable materials; the 20% of all aggregate used in the concrete is recycled; and the 90% of the steel used had a recycled content.

It is clear from the above discussions that the UAE organisations have been implementing various green strategies into their projects. Global CO2 emissions track an upward trend and expected to keep on growing. Construction industry has a massive and increasing impact on the environment; globally, 40-60% of total energy consumption results from building construction, operating; heating, lighting, ventilating, maintenance, and servicing which results in high energy cost for both individuals and business levels, as indicated by, Zhou et al., (2014) and Hoseini et al., (2014). Additionally, buildings generate massive amounts of Greenhouse Gas emission (GHG), which makes them a major responsible for the global warming, Zue and Zhao (2014) and Green et al, (2015), in the time when climate change has become one of the most critical problem (Ji et al., 2009 and Ruparathna et al. 2016).

Green et al. (2015) noted that buildings have a significant contribution to the value and the stability of the economy. The construction industry constitutes around one-tenth of gross domestic product (GDP) worldwide. Nonetheless, it is a significant employment generator and provides work to almost 7 per cent of total employment population globally, Pearce and Ahn (2012).

Buildings consume large quantities of resources and have a major impact on our health, wealth, and environment. Buildings are critical to our success as society, as Green et al., (2015) pointed out that we spend, in average an amount of time in buildings that deserves to ensure that the indoors and outdoors environment meet our physiological and psychological needs, Ruparathna et al., (2016).

In view of these findings, Ries et al. (2006) and Shafaghat et al. (2016), argued that investigations into sustainability are increasing with a significant demand for low embodied energy and low carbon energy efficient buildings, ensuring generating minimum waste, considering the whole lifecycle of buildings counting renovation and deconstruction, required by all participants which representing a major opportunity to implement sustainable development in the construction industry, Yuan et al. (2013).

The aim of sustainability is to allow people to achieve their needs and enhance their wellbeing, while conversing and protecting the ecological system and its diversity, considering current and future generations. According to Zue and Zhao (2014), Chatterjee (2009) and Gluch (2006), green or sustainable building is a significant measures put forward to mitigate significant impacts of the building stock on the environment, society, and economy, reflecting the efforts put forward to apply sustainability in building manufacturing, by developing green building strategies, designs, standards, and assessment tools. Zue and Zhao (2014) go further and defined four pillars of green buildings, highlighting the associated social impacts rather than the environmental and economic ones, e.g. enhancing occupants and local community health conditions whilst discussing the turn on investment to developers.

8.4 THE KEY CHALLENGES FOR IMPLEMENTING GREEN BIM IN THE UAE CONSTRUCTION INDUSTRY

In this study, interviewees were asked to describe key challenges for implementing green BIM sustainability features which were incorporated into the BIM implemented projects through face-to-face interviews. The results indicate lack of common knowledge in relation to green BIM requirements, having multiple ways of creating and recording digital information involved teams working in a different manor to others. Unless the green BIM scope is thoroughly specified from the very start the expectations of what BIM can bring to a project and the reliance of the 3D model cannot be achieved. A drive for BIM education within the infrastructure industry needs to be established, knowledge of how to apply the principles of BIM into infrastructure projects is insufficient.

Training requirements are a contributing factor against the successful implementation of BIM. The challenges faced involve software and choosing the right software to use. Confusion between client and designers is evident as software developers push for their products and integration between each platform fails to be achieved. The additional cost to train staff and purchase the clients required software platform for BIM implementation adds to the project's cost and can contribute to a bid becoming unsuccessful due to not being competitive in today's market. In addition to obtaining the required software, purchasing hardware ensuring the computing power is available will also add to the final project cost.

Model quality is another challenge identified by the interviewers. According to Smith (2014) the quality of BIM models is of major concern for construction organisations. As these models require the input of vast amounts of complex interconnected data and information, clients may not be prepared to invest in the proper development of a quality model; often the limitations are brought about by consultancy fees that are insufficient to develop the model to the required level. Autodesk (2012) expressed that 100 per cent of projects that did not reconfigure poorly setup models bore approximately $24,000 of costs downstream in the project. It is clear that the concept of poor information inputted will result in poor output certainly holds true for BIM models and the liability for the use of inadequate or incorrect information is a concern.

As follows is an example of model quality issues; from the findings of Maki and Kerosuo (2015) the hindrance in the use of BIM was inaccurate and missing information in some models. The models included an extensive amount of information, but there were times where specific information needed for construction or demolition was lacking, not accurate enough or even wrong. In some cases if a member of the project team found something wrong or missing in the model, the member did not notify the rest of the designers of this issue. As a result, original plans to keep an old chimney in the design were changed to be demolished instead. However, unfortunately this change was never updated, thus by after all the demolition was finished, the chimney was still present and it took three working days for the designers, managers and supervisors to make a new decision about this issue.

In order to avoid waste of time and money, someone has to choose a suitable level of detail for the model, which is another issue cited by the interviewees. As it is often necessary to choose if the information required for certain analysis should be added in advance, there is often not enough time to add this information in retrospect as the project progresses (Fazli et al., 2014).

Management issues mass around the implementation and use of BIM. Currently, there is no clear consensus on how to implement or use BIM (Azhar, 2011). Lack of BIM standards for model integration and management by multidisciplinary is a risk to the effectiveness throughout the project life-cycle. Due to this each organisation adopts its own protocols. However, this could lead to inconsistencies, which if not detected may lead to an inaccurate and inconsistent BIM model (Azhar et al., 2012). Thus, there is need to standardise the BIM process and to define guidelines for its implementation in the UAE construction industry.

One major issue with the implementation of BIM is the obstacle that involves changing people habits, often needing to overcome a significant degree of resistance (Dassault Systemes, 2014). In others words, changing the mind set of staff to embrace and evolve with this technology to overcome the conservatism and inability to adaptation (Smith, 2014). In particular, when new processes and ways of working are introduced in an organisation, this may result in internal clashes or even paralysis while processes are reconfigured. For example, bottlenecks could occur while designs are being refined and assessed (Dassault Systemes, 2014). Smith (2014) found that there has been clear shifts in attitudes in the last few years as professional staff realise that if they do not evolve, they will be left behind. Indeed, the younger generation moving into the profession are more amenable to digital technologies and change and in many ways represent a threat to more senior personnel resistant to change.

The advent of BIM has been faster than the ability of organisations to adapt their corporate governance by incorporating BIM into their corporate management system. Xiao and Noble (2014) found that many organisations are still at the preliminary stage and only manage to provide some basic facts of what BIM is, not the more practical guidance on how to use BIM to actually management a project. In addition, organisations have not had a well-thought strategy in place to manage changes and it is up to the individuals to invest time and effort in learning and educating themselves (Xiao and Noble, 2014). Fazli et al. (2014) explains that various researches show that cost and time needed to train staff to work efficiently with BIM is much more than what organisations can afford, which makes them less interested in BIM. This implies, that UAE construction organisations need to find a way in order to lessen the learning curve of BIM trainees.

There are various organisations that focus on production and operate in the construction phase. Architectural and consultancy firms operate in the design phase and lack of financial resources of smaller organisations prevents them from investing in new technologies such as BIM (Fazli et al., 2014). Even larger organisations will inevitably face the problem of lack of funding. Currently, all relevant modelling software is relatively very expensive, meaning the investment price is usually thrice or more of the value of traditional 2D CAD software (Tulenheimo, 2015). According to the NBS (2012) adopting BIM can cost a practice $10,000 per workstation. Moreover, to keep updates running and getting new versions, subscription fees have to be paid seasonally. These fees are 5-20 per cent of the original investment prices (Tulenheimo, 2015). For all that, it depends on whether implementation is simply an exercise in buying hardware, software and then training staff to use it, or whether it is part of a wider process of business change.

Indeed, there are still interoperability issues that pose a risk. From the induction of Industry Foundation Classes (IFC) and XML schemes have significantly helped to answer the call of interoperability issues, but still both of these approaches have their inherent limitations. According to Azhar et al. (2012) for any construction project users must research interoperability whilst selecting BIM software applications, in order to reduce this risk.

The legal and contractual issues were highlighted by the interviewees in this study. Smith (2014) expressed that this needs to be resolved before the full collaborative potential of BIM can be realised. Lack of determination of ownership of the BIM data and the need to protect it through copyright laws and other legal channels. There is not a simple answer to the regarding data ownership, meaning it requires a unique response for each project dependent on the participants needs (Azhar et al., 2012). The target is to avoid disincentives or inhibitions that discourage participants from fully realising the potential of the model.

Taking responsibility for updating BIM data and ensuring its accuracy of course entails a great deal of risk. Thus, another contractual issue is who will control the entry of data into the model and be responsible for any inaccuracies. This requires more time spent inputting and reviewing BIM data, which will be an additional cost in the design and project administration process. Indeed, the efficiency and schedule gains may offset these new costs, however, they are still a cost that's incurred by someone upon the project team (Azhar, 2011).

Responsibility for the accuracy and coordination of cost and scheduling data must be contractually addressed. For example, as the dimensions of cost and schedule are placed upon BIM, responsibility for the proper technological interface among various programs becomes an issue. In cases where the data are incomplete or are submitted in a variety of scheduling and costing programs, a team member which is usually the general contractor or construction manager must re-entre and update a master scheduling and costing program making the integration less fluid (Azhar, 2011).

Another disputed issue highlighted by interviewees is whom should develop and operate the models. As protecting the intellectual property (IP) of the design and the data embedded in the model are critical for maintaining designer confidence in the process; including confidential information and trade secrets such as construction techniques and sequencing (Manderson et al., 2015). As a result, of the shift towards e-communication concerns have become raised regarding appropriate levels of data security and protection. Indeed, ensuring data is protected against corruption, loss and manipulation, requires detailing restrictions and requires a level of insurance to cover any possible financial losses associated with breeches of data.

The integrated concept of BIM blurs the level of responsibility so much that risk and liability are likely to be enhanced (Azhar, 2011). Professional Indemnity (PI) is of major concern for design professionals involved in BIM. By default, participating professionals become liable for the design contributions of non-professionals, including automatic changes by software (Manderson et al., 2015).

8.5 IMPACT OF GREEN BIM UPON UAE CONSTRUCTION PROJECTS

Remaining competitive is of great importance for any business, organisations must adapt to evolving markets to remain sustainable for the future. Achieving competitiveness throughout small and large construction companies should be achieved; applying a threshold for when BIM is mandatory needs to be pursued. Implementing green BIM increases cost to any project, offering this service will require the service to be itemised separately for clients so they are aware of the upfront costs, due to the concerns of looking uncompetitive. Green BIM has been evidently slow in progression. To achieve competitiveness all need to abide by the same set of standards, those that don't should be penalised for not doing so. Offering 3D visualisations of an construction project allows clients and designers to virtually walk around a digital 3D environment, this will supply a business with an advantage when compared to a business that doesn't. Enabling virtual tours of the project can identify potential clashes, design faults and health and safety issue before construction takes place. Identifying faults during preliminary design status rather than at construction will save project costs substantially and will also improve the deliverable of the construction programme.

One of the interviewees noted that they witnessed green BIM project delivery within the agreed timescales with the reduction of potential design errors which could have delayed the programme of works. The ability to analysis potential clashes was benefited for the different disciplines working on the project. The BIM processes includes project management, for the remainder of interviewees it could be considered as professionals shying away from additional workloads and only implementing BIM for design, this could be another reason for slow progression within the construction industry. Due to the lagging progression of BIM it is too early to accurately measure the benefit of early programme delivery and this will need to be measured in the near future.

Even so green BIM implementation must reach across a business, it cannot be an ICT initiative or a R&D one, or done solely at a project or disciplinary level. While these approaches yield some results, in the end do not transform a business and deliver only a portion of the benefits BIM can provide in reducing cost of poor quality. It is important to remember however, that business change is often difficult and is not always successful. Xiao and Noble (2014) in their research expressed that for the project performance in cost, time and quality, not one of their interviewees stated that it directly improved any of these elements, which, suggests in this circumstance it did not help reduce cost of poor quality. In addition, found that green BIM was actually a disadvantage as the lack of collaborative working meant version control was lost, which increased cost of poor quality.

8.6 SUMMARY

The present study was evaluated the current state of the implementation of green BIM within the UAE construction sector. Problems encountered since the beginning of the investigation started to point out the lack of maturity of this issue within the construction industry, and the little knowledge that we have about the benefits and multiple applications that have BIM, when it is desired to develop sustainable projects.

First of all, despite the fact that the governments of countries such as the US, the UK, Norway, Finland, Korea and Singapore, have established policies for the full adoption of BIM in public projects for the purpose of obtain more profitable, efficient and sustainable projects, this is not absolutely certain in the UAE that this policies will be implemented. As revealed in this study there is still a lack of understanding about the implications of green BIM on a project. The construction industry should still develop projects where green BIM is properly implemented in order to be appreciated all its benefits. Though, the idea of applying green BIM represents an increase in the initial project costs, discourages the adoption of BIM in a market that is not required to implement BIM yet.

Secondly, once you investigated the benefits that BIM can deliver and to facilitate the process of obtaining a Green Building Rating Certification. This proves to be advantageous: the adoption of BIM would increase, and the amount of CO2 emissions produced by the construction industry would decrease, through the development of more green projects. But there are major limitations to this solution. The implementation of BIM remains a challenge for the UAE construction industry in general, and its applications in sustainable projects are even more difficult.

Moreover, the high cost of green BIM represents the implementation and development of green projects, it is not very attractive for developers of small projects. It is difficult for the builders involved in this sector decide to engage in this movement, if it is easy to appreciate that the projects analysed as case studies are of great dimension.

Another important aspect is that client demand is a major barrier when developing Green BIM projects. It is unlikely that clients of small sustainable projects ask for the development of their projects with BIM. To build sustainable projects, and projects using BIM tools, involve a large investment in the initial project costs, which does not represent benefits for developers who are only interested in infrastructure, and not in the stages after construction.

As already explained, each country plays an important role regarding the implementation of BIM and sustainable projects development. The creation of standards and targets to be followed by building professionals, have served as a guide to achieve the objectives in every project. Sustainable construction is of international concern. Awareness about the importance of sustainable construction has increased, which will increase the number of buildings and projects developed in this way. Regarding green BIM, remember that is in a process of transition, and should be taken with patience.

Cannot be predicted when will be widely implemented BIM on green projects in the UAE construction industry, but certainly, there is still a long way to go. The first is that for this to happen, the general implementation of BIM has to reach the highest levels. Because the main goal of BIM is the public sector, it is likely to be the first to adopt BIM in all its practices. Once this implementation is mature, it may take the private sector and sustainable projects. Although in this research can be seen that the private sector is the largest developer of Green BIM projects.

Overall, the following inferences and implications could be drawn:

- The countries leading the implementation of BIM worldwide, such as the United States and the UK, have set targets that drive their application in the construction industry, however there is still the need to disseminate knowledge about what is green Building Information Modelling and benefits involved in their use in an infrastructure project. Not worth developing excellent programs and regulations, if there are no trained professionals in the area. Green BIM is a process that involves all stakeholders of a project, from the contractors to the client. If any of them are not trained to follow the desired flow, the project will not have the success and the expected results. It would therefore be beneficial to the UAE government provide financial and economic support for the education of the different professionals in the construction sector.

- The UAE government is looking for solutions to reduce emissions of carbon dioxide and broader sustainability issues. Something that contributes greatly to achieve this goal is to develop more sustainable projects, where the least amount of non-renewable resources are consumed, and measures of prevention and mitigation of possible negative impacts are included.

- Encourage the development of more environmentally friendly construction methods with the environment that can be applied in different types of projects, based on green BIM tools. As the buildings are entities requested and used by people, it is imperative that the community is aware of the benefits that entails the implementation of green BIM and sustainable policies, which may be required for its adoption. Therefore, the diffusion of the green BIM methodology and sustainable construction, through programs, and communication and advertising campaigns, help governments to fulfil their objectives and contribute to the strengthening of the UAE construction industry.

The Chapter 8 has addressed the fifth research objective, which is “to critically analyse the implementation of green Building Information Modelling (BIM) strategies in achieving the sustainability goals of the UAE construction organisations” and fifth research question, which is “what are the key green BIM strategies currently being implemented in in achieving the sustainability goals of the UAE construction organisations” of this study. The next Chapter (Chapter 9) will discuss the implementation of mobile application technologies to address sustainability issues in the UAE construction industry.

CHAPTER 9 : MOBILE APPLICATION TECHNOLOGIES TO ADDRESS SUSTAINABILITY ISSUES IN THE UAE CONSTRUCTION INDUSTRY

9.1 INTRODUCTION

The purpose of this Chapter is to discuss the implementation of mobile application technologies to address sustainability issues in the UAE construction industry. The results are based on the perception of the 44 participated interviewees. The findings are also substantiated with the relevant literature. In this study, interviewees were asked to describe uptake of mobile applications, reasons for using, and usage in their organisation through face-to-face interviews. Each of these key dimensions is discussed in details from section 9.2 to 9.4. Finally, section 9.5 summarises the key findings. In doing so, Chapter 9 addresses the sixth research objective, which is “to critically analyse the implementation of mobile application technologies to address sustainability issues in the UAE construction industry” and sixth research question, which is “how can the implementation of mobile application technologies support UAE construction organisations in the mitigation and control of their current sustainability problems” of this study.

9.2 UPTAKE OF MOBILE APPLICATIONS TECHNOLOGIES IN THE UAE CONSTRUCTION INDUSTRY

In recent years, the UAE construction sector has made remarkable achievements in the implementation of information and communication technologies. In this study, during face-to-face interviews, in order to capture the general uptake of mobile applications in the UAE construction sector, a question was raised, i.e. what do you think of the uptake of mobile applications in the UAE construction sector? The current study results revealed that, 16% (7 of the 44) of the interviewees noted that the UAE construction sector is advanced in adoption of mobile applications, 75% (33 of the 44) of the interviewees agree that the UAE construction sector is still in developing stage in adoption of mobile applications, and the other 9% (4 of the 44) of the interviewees think the adoption of mobile applications in the UAE construction sector is falling behind. Results clearly suggest that the adoption of mobile applications in the UAE construction sector is still in the developing stage. For instance, one of the interviewees noted that:

> "Although our key contractors use mobile technology quite widely to manage our supply chains, we are at the early stages in our journey in terms of implementing mobile technology to manage our relationships with our main contractors. This is mainly because the works information specifies the use of enterprise bridge for all document management so the onus is on our contractors to provide the require information in a specific format. Requesting or making charges to how the procure and manage this information would mean additional cost to our programme, so there has been resistance to implementing new technology that has not been specified in the contract."

Although there has been implementation of Information Technology in several levels of information management in the UAE construction industry, construction projects occur in locations where access to conventional computer systems can be limited (Chen and Kamara, 2011). As a solution to this, the construction industry has found mobile technology to be an approach to obtain and process information (Saidi, et al, 2002). Hyojoo, et al, (2012) agrees and mentions that the inaccuracies and the rescheduling that manual input of information causes can be eliminated and data can be efficiently managed using mobile computing. The statements from these authors can be verified in Box (2014) as their report shows the increasing use of mobile devices from the construction industry.

There are, however, human and technological factors that affect the implementation of mobile computing in the construction industry. In the human aspects, Usmad and Said (2012) exposed a group of factors that affect positively and negatively the management of construction projects. Factors that aid ICT in construction site are the awareness about the benefits of ICT from users, the knowledge of the concept and a previous exposure to ICT devices. Meanwhile, among the factors that have a negative impact on ICT in construction, are mentioned: the operational difficulties of ICT devices and security uncertainty of these. Moreover, Adiraanse and Voordijk (2005) emphasize on features of interorganisational communication in construction projects to evaluate difficulties for effective use of ICT. Two paradigms are studied that involve human behaviour, the traditional functionalist and the radical humanist. For the traditional functionalist, ICT makes no relevant influence on his decision making, as for him/her communication is only a mean to distribute data. Secondly, the radical humanist has a tendency of analysing information systems and criticize the current state of information organisation methods.

Finally, the level of knowledge from the final user to operate the technological developments on site, along with other user-specific factors, determine the successful execution of ICT as mobile technology. Alshawi and Faraj (2002) state that an exclusive investment in technology would not result in positive solutions for businesses. This was later discussed by Chen and Kamara (2011) where it is stated that mobile users software functions demands will vary according to their specific roles within the project.

Moreover, it is added that if the user presents difficulties in understanding the technologies, training and education prior to the implementation of the technology is necessary. Nevertheless, not only the human aspect is involved in mobile computing in construction operations; but also the technological characteristics of the devices, and how suitable these are for the industry, play a key role in the successful application of mobile computing.

Chen and Kamara (2011) and Saidi, et al, (2002) explain the activities that are suitable for mobile technology and the activities that are not. Construction data that needs to be transferred instantly, tasks that require access to information or documents that need to be revised in a simple format, would perceive improvement if mobile technology is applied. On the contrary, when complex computing needs to be made or big documents need to be viewed, mobile computing would not bring a feasible solution. Usmad and Said (2012) also state that the deficiency in devices specifically made for the construction industry is one of the factors that affect ICT innovation in construction site management.

Also, Stewart, et al, (2004) studied the barriers of information technologies in construction companies and identified that at industry level a reduced inter-operability amongst applications and organisations is presented. This is also explained in Chen and Kamara (2011), their study stipulates requirements that mobile technologies must have so that practicability can be achieved. Primarily, long lasting battery life is necessary since the use of mobile computers happens in site, where power outlets scarce. Correspondingly, components such as processor capability and network compatibility need to be present in levels that will sustain the amount of data intended to be traded and stored.

The current study results showed that there is existence of resistance to add mobile technology to the UAE construction projects, it is believed that factors like the age in well-experienced professionals and non tech-savvy individuals as well as reluctance to change and innovate are part of the reasons why mobile technology has not yet taken off as wanted. Regardless, the findings presented in Hyojoo, et al (2012) showed factors that affect positively the introduction of mobile technology to construction, like promotion from the management team, among others.

9.3 REASONS FOR USING MOBILE APPLICATIONS IN THE UAE CONSTRUCTION INDUSTRY

In this study, during face-to-face interviews, a question was raised, i.e. what are the reasons for using mobile applications in your organisations? Most often noted reasons for using mobile applications in their organisations include: to manage Environmental Health & Safety (EHS); to management energy; to manage site waste; to manage water; to reduce capital costs; to reduce completion time; to improve predictability; to improve productivity; to improve revenue; to enhance demand forecasting; to enhance inventory management; and to enhance site logistic planning. For instance one of the interviewees noted that:

> "Even though Mobile applications in Health and Safety has had a big positive impact, this was possible because of safety protocol and processes for supporting its use, otherwise it would have been negative".

Another interviewees noted that:

> "Mobile Computing is a relatively recent addition to the tools available within our organisation, focussing on capturing information on site in terms of quality or H&S information. Additionally to this, we have started using larger screens to review up to date design details while on site rather than referring back to the PC's in the site offices or to printed drawings. This process is in its infancy really with much more potential to be gained."

Mobile technologies in construction sites have helped supervisors create better documentation of the occurrence of accidents. By using documentation software in mobile devices, pictures can be added to the reports, as well as clip a portion of a plan. This information can also be directly transferred to the management team for review and future reference (Löfgren, 2007). Some of the past literature, like found in Saidi, et al, (2002) explain that there is no improvement in the duration of a project when mobile technology is applied at task or activity level, in order for time reductions to be perceived, these technologies have to be implemented to multiple tasks. It was however clarified the importance and relevance of handheld computers and the benefits it has on construction site management, primarily by giving site workers the ability to send and receive information in real time to project decision makers.

Furthermore, Bowden, et al (2006) lists the improvements that the construction practice can have with the successful implementation of mobile ICT, these include the reduction in construction time, in capital costs of construction, in defects, in accidents, in predictability, in waste, in operation and maintenance and in productivity. The study also indicates the effects that will experience the construction industry with this new technology. Firstly, an adjustment of the current human resources methodologies has to take place, where knowledge of technology and communication with multi-disciplinary teams is required in every level of the team. Secondly, the development of mobile technology will demand the incorporation of knowledge management to be applied in more levels of the construction industry; where information and communication of meetings and decisions will be accessible to all members of a project.

Phillip and Thomson (2014) reported on mobiles and tables as tools for capturing data and executing tasks, and their projections for mobile computing for the year 2020, show that mobile technology hasn't been fully applied in the construction industry and that there is plenty of room for improvement and implementation in the sector, and move towards the use of these technologies as a standard practice.

However, O'Hara (2015) states that factors such as affordable tables and the cloud computing are the main influencers in an uptake of mobile technologies in the construction sector. Overall, the mobile technology subject in the UAE construction industry is a very relevant and contemporary issue that is being much discussed in conferences, reports and academic papers, as it is believed to have a very important impact in the industry and in the future of construction projects in general.

9.4 USAGE OF MOBILE APPLLICATIONS TO MITIGATE SUSTAINABILITY PROBLEMS

Global climate change has been raising concerns all over the planet, which in addition to the unstable energy markets, has started some notions in the sustainable information and communication technology (Bronk et al., 2010). As a result, mobile applications are playing a fundamental role in the creation of new technologies that can tackle the sustainability problems. In this study, during face-to-face interviews, a question was raised to explore the usage of mobile applications to mitigate sustainability problems in their organisations. Many interviewees noted that their organisations have already started to pursue technologies by creating a set of mobile applications that seeks to mitigate the sustainable issues. And as it was previously mentioned, tackling these problems at a company level is imperative due to the influence that these organisations cause on the environment. Some of the areas construction organisations that are being currently tackled by these technologies are energy management, carbon emissions management and construction health and safety management.

9.4.1 Energy management Apps

Nowadays, the only way of improving the emissions generated by these activities is through new technologies and economic methods. Nevertheless, an emerging approach is focusing on changing the behaviour of humans in terms of the way energy is used (Froehlich, 2009). As an example, the inhabitants' behaviour directly affects the electricity consumption of residential buildings. In spite of this, a limitation that appears when households try to save energy is the lack of information on how their electricity is consumed. It is demonstrated that the monthly feedback generated in the bill does not provide the necessary information to support the willingness of saving energy. As a result, the provision of the consumption of house appliances is required (Weiss et al., 2009). In addition, Froehlich (2009) expresses that without this type of reports the consumption of electricity in houses is often overlooked, as most people do not pay attention to either their energy usage or their environmental impact.

For instance, one of the interviewees noted that their organisation has utilised an Application to control a set of features in order to manage every part of their sustainability footprint and to accurately calculate energy usage and trends. In addition, it also includes the management of heating, cooling and lighting, which are a critical player in the consumption of energy. This is undertaken as an attempt to acquire a remarkable sustainability performance. The features that the organisation control includes the consumption of electricity, use of fossil fuel, generation of waste, usage of water, and the generation of carbon emissions as part of their operations. The inclusion of all of these measures provided a series of benefits to the organisation. These benefits included in time management of sustainability targets, control of the impact that each department produce, more efficient management of key performance indicators by including timely and precise reporting, and management of relevant data regarding electricity, water, fossil fuel, waste, transport and supply chain.

The implementation of products that can illustrate real-time consumption such as smart power outlets are presenting issues in providing a solution as they possess a high usage barrier and demand a complex initial installation. Furthermore, they do not provide information that can enforce users to take decisions such as the comparison of the consumption of various devices (Weiss et al., 2009).

In the same way, studies explain that by providing timely feedback and guidance on the energy consumption, the user behaviour is changed and energy conservation is encouraged. It has been demonstrated that by generating timely and detailed feedback between 5 and 15 percent of household's energy consumption is reduced, which results in savings from changing their behaviour (Weiss et al., 2009).

Wrong assumptions on how the energy is consumed are directly linked to taking wrong decisions to save energy. It is explained that there is a wide range of misunderstanding regarding the benefits of weatherization, tax breaks and retrofits (Geller et al, 1982, Froehlich 2009). As a result, the education of consumers must be part of the smart feedback systems in order to obtain appropriate results (Froehlich, 2009).

In order to close the existing gap in this subject and provide an efficient system, it is necessary to incorporate real-time to a device level. The proposed system would integrate smart meters with web-based systems in order to allow the easy interoperability with other applications that can be built on top of the system. Furthermore, the user interface of mobile phones provides both continuous and timely feedback and the continuous interaction, control and comparison of the devices' consumption (Weiss et al., 2009).

In conclusion, tackling the behaviour of human is fundamental in power expenditure. It was illustrated that the feedback technology reduced the power expenditure by 10-15% on average, which would result in a notable reduction in the emissions of carbon dioxide. This technology is said to enhance and provide more data and visualisation as the price of the meters is tending to decrease (Froehlich, 2009).

9.4.2 Carbon emissions management Apps

According to Kampa and Castanas (2007), one of the human activities that produce more contamination to the air is the transportation. Froehlich et al (2009) explain that this human activity can be adequately enhanced with the support of mobile devices. In addition, it can be seen that a wide variety of issues are currently affecting urban traffic. These issues include infrastructure additions, pollution, congestions, sustainability, or capacity limits. With the support of applications and services, these problems are being tackled at a personal level by improving instantaneous traffic information with Google

Now, mobility information with IYOUIT, vehicles rental with GreenWheels, navigation with Google Maps, or trip sharing with Avego (Broll et al., 2012).

These implementations take advantage of the benefits that mobile applications offer in order to improve the user experience on transport, commuting, and travelling. Furthermore, mobile applications are also able to encourage the change in users' behaviour by influencing individuals to take a more sustainable decision (Broll et al., 2012). This represents an important mechanism that can allow a substantial reduction of the environmental pollution that this activity generates.

An example of this type of applications that can enhance personal mobility is tripzoom. This mobile application was first developed in order to research how the supervision, incentive, and social networking can influence people's mobility behaviour and make it more sustainable. In order to achieve this, tripzoom generates a mobility profile with the user's behaviour, and based on that, the user's behaviour is then stimulated by offering incentives and by providing an overview of their performance on costs and carbon dioxide emissions that can be compared to the community over social networks (Broll et al., 2012).

9.4.3 Health and safety Apps

According to Burke et al. (2011), the International Labour Organisation (ILO) stated that accidents at work or occupational diseases claim the lives of 2.2 million annually. Sectors, such as the construction industry which remains as one of the most dangerous in the UAE, possess impacting rates of fatal injuries. On the other hand, it can be seen that tackling health and safety problems requires an effective management approach. Stranks (2005) explains that management is the adequate use of resources in order to achieve the organisation's objectives. This management involves the comparison between the risks of operations and the costs of reducing or eliminating those risks, and the health and safety management is not different from this.

Health and safety management implicates planning, controlling, organising, measuring the performance, and motivating managers. In the same way, it also includes the decision-making process which is a vital process in management. The management of Health and Safety involves everyone within the organisation and their personal behaviour, even if the personal factors such as perception, attitude, motivation, character, and training. In addition, it incorporates the acceptance of change, along with the problem of stress and the role of each member of the organisation (Stranks, 2005).

On the other hand, as the management Health and Safety is fundamental for the efficient management and development of an organisation, further efforts have been performed in order to handle this fundamental element with the environment by implementing mobile application technologies that can provide its ubiquity attributes as a solution.

For instance, the SAP software offers a suite for the environment, health, and safety. It not only focuses on producing a positive impact on the environment, but it also accomplishes the reduction of cost along the way, improvement of operating margins, increase of brand's reputation, and attract new investors.

9.5 SUMMARY

Mobile Applications can offer a variety of benefits and capabilities to the management of construction Environmental, Health, and Safety issues. However, the effective arrangement of these capabilities is what defines whether an application is effective or not. It was observed that the main benefits obtained by using Applications include an enhanced reporting of sustainability metrics that enforce decision making, reduced energy consumption, and more efficient waste management.

The study revealed that the uptake of mobile applications in the UAE construction industry is still in developing stage. Most often cited reasons for using mobile applications in their organisations include: to manage Environmental Health & Safety (EHS); to management energy; to manage site waste; to manage water; to reduce capital costs; to reduce completion time; to improve predictability; to improve productivity; to improve revenue; to enhance demand forecasting; to enhance inventory management; and to enhance site logistic planning. Some of the areas construction organisations that are being currently tackled by these technologies are energy management, carbon emissions management and construction health and safety management.

It is said that selecting sustainable software has become an arduous task due to the constantly changing technologies, unclear pricing structure, incomprehensible business needs, and uncertain future of technologies (Davies, 2012). Thus, the selection process is considered to be a multi-criteria decision making (MCDM) which generates problems due to the conflicting assessment criteria (Singh et al., 2016).

The effective consideration of these characteristics to choose adequate software can heavily benefit the company by reducing time spent on lowering the sustainability issues that can be utilised in adding value to the business in order to achieve success (Davies, 2012). This is fundamental as the extremely competitive market has forced companies to modify their business environment in order to maximise profits, minimise cost, reduce lead times, and provide rapid solutions to customer needs (Wei et al., 2004).

Davies (2012) presents a methodology based on six criteria which are functionality, technology, cost, services, viability, and vision. Functionality is the most relevant criterion according to the weight distribution. This is due to its relationship with the need that triggered the purchase decision to incorporate the software capabilities to support business operations. It is fundamental that future changes are considered within this section, as well as the incorporation of collateral features and configurations such as specific format reporting, languages, and password protection. The second measure regard with the technology implemented to run the software which should contemplate the use of cloud computing in order to avoid having to manage hardware, databases, and web servers. Cost is the third criterion and it is easily evaluated by assessing the Total Cost of Ownership (TCO) over a 3 year period (Davies, 2012).

On the other hand, the services aspect includes the installation process and the on-going support which must be performed seamlessly with the companies' operations. The viability measure involves the evaluation of risks and must be assessed with the finance, the product, and the organisation strategy of the company. Finally, the last measure refers to the future plans of the product, services and corporation (Davies, 2012). Overall, the following inferences and implications could be drawn:

- As it was seen, sustainability issues are dynamic and depend on many variables that can change over time. As a result, the continuous control and supervision are necessary in order to assure an effective management of the problems related to sustainability. As a solution to this, the construction industry has found mobile technology to be an approach to obtain and process information.

- The UAE construction sector is trying to modernise the form in which projects are being undertaken and is looking at sustainable mobile applications as a portable and feasible solution for better communication, integration and collaboration tool.

- The UAE construction organisations that have implemented sustainable mobile applications have experienced positive benefits include a precise, clear and reliable reporting system with potential scalability, an enhanced timely tactical decision-making, a more efficient management of hazardous materials and waste, a well-organised management of KPIs, and an overall improved control of electricity, water, fossil fuel, waste, transport and supply chain. However, selecting the appropriate application that can meet the organisation's requirements is imperative. In addressing the adequate application, organisations must consider the different factors that were presented in the software selection framework. This can ensure the right selection of the software that provides more benefits to the organisations strategies towards sustainability.

- It is concluded that the benefits obtained from the implementation of sustainable mobile applications prove to be an assurance to the mitigation of organisations' sustainability problems. Furthermore, it can be assumed that these benefits can be extended to other UAE construction organisations that are willing to implement this technology. And in order to attain this, it is necessary that more regulations and incentives from the UAE government are implemented in the country that can guarantee the increase of the organisations' encouragement with sustainability approaches.

The Chapter 9 has addressed the sixth research objective, which is “to critically analyse the implementation of mobile application technologies to address sustainability issues in the UAE construction industry” and sixth research question, which is “how can the implementation of mobile application technologies support UAE construction organisations in the mitigation and control of their current sustainability problems” of this study. The next chapter (i.e. Chapter 10) will discuss the development and validation of sustainable framework for managing sustainability strategies in the UAE construction industry.

CHAPTER 10 : A FRAMEWORK FOR MANAGING SUSTAINABILITY STRATEGIES IN THE UAE CONSTRUCTION INDUSTRY

10.1 INTRODUCTION

This chapter presents a framework for managing sustainability strategies in the UAE construction industry. The findings from the previous stages of this research study were taken into consideration in the development of the framework. The developed strategic framework uses the environmental, social and economic dimensions of sustainability as its foundation. The developed framework provides broad guidance for the integration of sustainability strategies into day-to-day operational decisions. Section 10.2 discusses the rationale for the framework. Section 10.3 discusses the proposed framework. While section 10.4 summaries the key benefits of the framework.

This strategic framework is intended to offer guidance for the successful implementation of sustainability strategies to simultaneously improve environmental, social and economic performance. In doing so, chapter 10 addresses the seventh research objective of this current study, which is “to develop and validate a framework for managing sustainability strategies in the UAE construction organisations”.

10.2 RATIONALE FOR A FRAMEWORK

For many years and with increasing visibility the managements of leading companies have been core drivers of sustainable development. With their innovations sustainable entrepreneurs and sustainability managers are shaping markets and society substantially (Schaltegger and Wagner, 2011). To be innovative means to provide organisational and technical improvements that can be sold successfully in the marketplace. In a market system, sustainable development requires sustainability innovation and entrepreneurs who can achieve environmental or social goals with superior products or processes that are successful in the marketplace of mainstream customers. Market innovations driving sustainable development do not necessarily occur by accident but can be created by leaders who put them into the core of their business activities. Actors and companies making environmental progress to their core business can be called sustainable entrepreneurs. They generate new products, services, techniques and organizational modes that substantially reduce environmental impacts and increase the quality of life (Schaltegger and Wagner, 2011).

All organisations need to change and develop if they are to remain competitive and satisfy clients' ever increasing expectations. The need to change is usually driven by external factors such as new legislation or increased competition, or internal factors such as the implementation of new technologies. However, the implementation of change is a complex process that is not always successful mainly due to poor communications or an underestimation of the amount of retraining required (Price and Chahal, 2006).

Change management is a structured approach to shifting/transitioning individuals, teams, and organizations from a current state to a desired future state. It is an organizational process aimed at helping employees to accept and embrace changes in their current business environment. In project management, change management refers to a project management process where changes to a project are formally introduced and approved. Change management is a systematic approach to dealing with change, both from the perspective of an organization and on the individual level. A somewhat ambiguous term, change management has at least three different aspects, including: adapting to change, controlling change, and effecting change. A proactive approach to dealing with change is at the core of all three aspects. For an organization, change management means defining and implementing procedures and/or technologies to deal with changes in the business environment and to profit from changing opportunities (Tamilarasu, 2012).

Change management processes may include creative marketing to enable communication between change audiences, but also deep social understanding about leadership's styles and group dynamics. As a visible track on transformation projects, organisational change management aligns groups' expectations, communicates, integrates teams and manages people training. It makes use of performance metrics, such as financial results, operational efficiency, leadership commitment, communication effectiveness, and the perceived need for change to design appropriate strategies, in order to avoid change failures or solve troubled change projects (Tamilarasu, 2012).

Successful change management is more likely to occur if the following are included:

1. Benefits management and realisation to define measurable stakeholder aims, create a business case for their achievement (which should be continuously updated), and monitor assumptions, risks, dependencies, costs, return on investment, dis-benefits and cultural issues affecting the progress of the associated work.
2. Effective Communications that informs various stakeholders of the reasons for the change (why?), the benefits of successful implementation (what is in it for us, and

you) as well as the details of the change (when? where? who is involved? how much will it cost? etc.).

3. Devise an effective education, training and/ or skills upgrading scheme for the organization.
4. Counter resistance from the employees of companies and align them to overall strategic direction of the organization.
5. Provide personal counseling (if required) to alleviate any change related fears.

   Monitoring of the implementation and fine-tuning as required (Tamilarasu, 2012).

Beer and Nohria (2000) noted that one of the key reasons for failure of any change initiatives is due to lack of an integrated framework for understanding change. Therefore, it requires a framework that allows executives to identify emerging sustainability issues, assess the impact of the company's ties on all its key stakeholders, measure the business value of relevant sustainability initiatives, and capture that value.

The emergent framework of the sustainability initiatives implementation process brought to light the interconnected nature between the activities within the process phases and the influence factors that affect the success of these activities. The lack of attention given to fulfilling all the activities within the phases and effectively managing the influence factors was observed to bring about poor or sub-par levels of achievements in terms of sustainability objectives. In this study, during face-to-face interviews, interviewees were asked the need for a framework for managing sustainability strategies in the UAE construction organisations.

Sustainability approaches may be categorised based on the hierarchical structure in their application, e.g., frameworks, analytical tools and metrics. In other words, these approaches can be assessed using frameworks or structured protocols to study several options within the framework using analytical tools, and to define such project occurrences using metrics (Srinivasan et al., 2011).

Of the interviewees, 95% (42 of the 44) cited the need for a holistic, comprehensive framework for addressing the issues relating to both the uptake and implementation of sustainability strategies. Many interviewees noted that their executives are familiar with managing business as usual, whether in terms of economic value added or other measures. However, their executives are less knowledgeable about developing, deploying, managing and measuring social and environmental issues and values. Considering the above discussions, it is clear that there exists a need for developing a holistic, comprehensive sustainability management framework. Such sustainable framework should be clear and easily understood by a variety of stakeholders with diverse backgrounds, who are involved in the different phases of the implementation process. The framework should also have a means of aligning and integrating the organisation level objectives and actions.

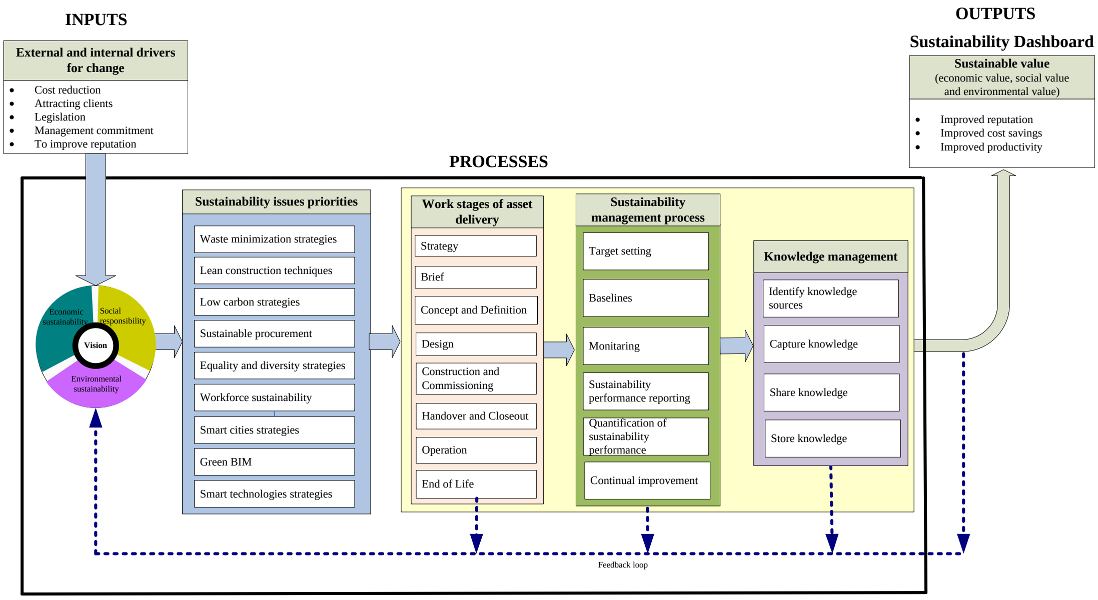


Figure 0.1: A framework for managing sustainability strategies in the UAE construction organisations

10.3 PROPOSED FRAMEWORK FOR MANAGING SUSTAINABILITY STRATEGIES

The framework was developed through a thorough review of literature and through data obtained from 44 professionals from the UAE construction industry. The proposed framework as shown in Figure 10.1 consists of 3 stages: inputs, processes and outputs. The inputs of the framework include the key drivers for implementing sustainability strategies. These inputs guide the decisions of sustainability strategies and the processes that the organisation undertakes to improve its sustainability agenda. After evaluating the inputs and likely effects on competitiveness factors, managers can develop the appropriate processes to address sustainability initiatives. Also, included in the framework are continual feedback loops that decision makers can use to evaluate and improve organisations sustainability strategy.

Most of the time organisations evaluate sustainability initiatives as “ineffective”, when the sustainability initiatives were implemented without fully understanding the drivers and the objectives that had to be met at the outset. Before embarking on a sustainability journey, organisations therefore have to understand what it is that they would like to achieve with sustainability and what value it needs to add to their organisation. Therefore, understanding drivers for implementing sustainability strategies is critical. This study revealed five drivers for implementing sustainability strategies in the UAE construction organisations. They are: costs reduction, attracting clients, legislation, management commitment, and to improve reputation (see Chapter 5).

Furthermore, this study revealed nine key initiatives under the umbrella of sustainability that have been implemented in the UAE construction organisations include: waste minimization strategies, lean construction techniques to promote Health and Safety practices, low carbon strategies, sustainable procurement strategies, equality and diversity strategies, workforce sustainability strategies, smart cities strategies, building information modelling and smart technologies strategies (see Chapter 6).

The effective implementation of sustainability management process when delivering built assets and programmes of work requires the engagement and involvement of many different stakeholders across the value chain. To align all stakeholders, a responsibility chart is provided for each work stage to inform as to the responsibilities of each value chain member and the activities to be completed. The levels of responsibility for each activity are defined as follows: Responsible – The go-getter of the activity; Accountable – The value chain member accountable for ensuring the activity is completed to the level required; Consulted – Value chain member who is actively engaged and contributes input to the go-getter of the activity; and Informed – Value chain member who is kept aware of how and when the activity is being completed and ready to provide inputs if necessary.

- **Strategy**

Key actions in this work stage to maximise effective implementation of sustainable management initiatives for sustainable value creation include:

- Show clear leadership for sustainability;
- Set bold targets and clear outcomes for sustainability;
- Engage the value chain early to share sustainability objectives;
- Remove any constraints to collaboration for sustainability;
- Define corporate governance for sustainability;
- Embrace a culture of challenge and change for sustainability; and
- Encourage and incentivise sustainable innovation throughout the value chain.

Responsibility chart

Sustainability activities during strategy work stage	Client	Designer	Contractor	Suppliers
Demonstrate leadership to reduce social, economic and environmental sustainability risks	R/A	R	R	R
Define building/infrastructure service outcomes including statement of need (define functional unit)	R/A	C	I	I
Set up corporate governance for sustainability that will include a continual improvement process	R/A	C	I	I
Set sustainability targets; or other relevant ambitions related to sustainability management	R/A	C	I	I
Early engagement with value chain partners	R/A	R	R	R

R: Responsible **A:** Accountable **C:** Consult **I:** Inform

- **Brief**

Key actions in this work stage to maximise implementation of sustainable strategies opportunities are to:

- Engage designers early to focus on building/infrastructure service outcomes and challenge the need for new assets;
- Allow time in the programme for designers to sustainable challenge the initial brief and review opportunities to further utilise existing assets;
- Clearly communicate desired building/infrastructure service outcomes but allow value chain freedom in how these outcomes are achieved to allow maximum scope for innovation;
- Select procurement routes (for other organizations in the value chain) that address whole life performance and incentivise sustainable construction;
- Engage constructors early to assess innovative sustainable construction techniques and materials;
- Engage product/material suppliers early to showcase sustainable solution alternatives to be considered during the concept and design work stages; and define the quantification methodology scope and cut-off rules.

Responsibility chart

Sustainability activities during brief work stage	Client	Designer	Contractor	Suppliers
Define the building/infrastructure asset/programme baseline based on a notional solution	R/A	C	I	I
Decide on sustainable impact quantification methodology;	R/A	C	C	C
Decide on project sustainability related data quality requirements	R/A	C	C	C
Decide on sustainability impact quantification tools to use throughout the different work stages	R/A	C	C	C
Develop sustainability brief following initial engagement with the value chain	R/A	C	C	C

R: Responsible **A:** Accountable **C:** Consult **I:** Inform

- **Concept and Definition**

The Concept and Definition work stages involve the initial evaluations of sustainability options for an asset and/or programme of work, followed by the selection of the preferred option before detailed design.

At the concept stage, there is still a large opportunity for achieving significant sustainability objectives. The asset owner/manager should encourage designers, constructors and product/material suppliers to challenge the brief and develop options to achieve the possible sustainable objectives for the project. This should be informed by the quantification, so that the maximum opportunity to intervene is provided.

Key actions in these work stages to maximise carbon reduction opportunities are to:

- Inform optioneering with whole life sustainability performance;
- Consider optimum sustainability objectives balance between during creating assets and during operation of assets;
- Reduce negative sustainability impacts during creation of assets by opting for sustainable materials;
- Reduce negative sustainability impacts during operation of an asset by reducing operational energy and resource use, and through integration of renewable energy systems;
- Consider impact of sustainability issues during the use of an asset by considering whole life sustainability impact;
- Influence end user behaviour to further reduce negative sustainability impacts;
- Consider early engagement findings (from Brief stage) from designers, constructors and product/material suppliers on ways to enhance sustainability performance (innovative products/materials and construction techniques, low energy processes, renewable energy systems); and

- Consider end of life scenarios and carbon emissions to inform asset layout and materials used.

Responsibility chart

Sustainability activities during concept and definition work stages	Client	Designer	Contractor	Suppliers
High level quantification of all options (and use of tools, where appropriate) against baselines	R/A	R	C	C
Challenge the need for a new asset. Set and refine objectives for subsequent work stages	R	R/A	R	R
Report on project activities and materials/components where the greatest negative sustainability impact occurs and where reductions can be made	I	R/A	C	C
Engagement with value chain for sustainability of design options, focus on preferred solution and its identified sustainability hotspots	R	R/A	C	C
Report and monitor sustainability progress against targets	R	R/A	I	I

R: Responsible **A:** Accountable **C:** Consult **I:** Inform

- **Design**

The Design work stage involves the detailed design of the preferred option. During this work

stage, further opportunities for sustainability should be considered and the relevant construction activities should be planned.

Key actions in the Design work stage to maximise sustainability opportunities are to:

- Optimise resource use and energy efficiency of the preferred design option through low carbon materials, leaner design methods, smart communication (Instrumentation Control and Automation – ICA) systems for operational efficiency;
- Consider end of life carbon and recycling options during materials selection; and
- Design for disassembly and material re-use at end of life.

Responsibility chart

Sustainability activities during design work stage	Client	Designer	Contractor	Suppliers
Engage with the value chain to seek innovation and cost efficiencies for reducing negative sustainability impacts and to use specific information where it is available in the quantification	R	A	C	I
Detailed quantification of anticipated project sustainability impacts against the baseline and target	C	R/A	C	C
Report sustainability hotspots to focus efforts for further reduction and record sustainability performance in pursuit of the targets	R	A	I	I
Set out specification requirements relating to sustainability and set challenges for procurement and construction	A	R	C	C

R: Responsible **A:** Accountable **C:** Consult **I:** Inform

Construction and Commissioning, Handover and Close out

The Construction and Commissioning, Handover and Close out work stages include the procurement and physical delivery of building/infrastructure asset.

Key actions during the Construction and Handover work stages, to maximise sustainability opportunities are to:

- Embrace innovative construction techniques to minimise waste, water, and energy use;
- Optimise construction waste, water, energy use to reduce negative sustainability impact from construction/commissioning activity;
- Capture lessons learnt and feedback as part of the continual improvement process.

Responsibility chart

Sustainability activities during Construction and Commissioning, Handover and Close out stages	Client	Designer	Contractor	Suppliers
Detailed quantification and record of project carbon emissions based on as built information	R	C	A	C
Use procurement to help embed the identified carbon reductions and challenge the value chain to seek innovation and cost efficiencies over and above design intent for reducing carbon	I	I	R/A	C
Engage with the value chain to use specific information where it is available (this might be on materials manufacture from the supplier; material quantity from the QS; etc.)	C	C	R/A	C
Monitor progress to ensure project design aspirations for carbon emissions are delivered	A	I	R	C
Report back to Asset Owner/Manager as part of the continual improvement process	I	C	R/A	I

R: Responsible **A:** Accountable **C:** Consult **I:** Inform

- **Operation**

Building/Infrastructure is operational during this work stage. The primary focus will be on optimising its performance to reduce energy and water usage as far as possible, or to extend its function.

Quantification should be based on measured activity or use data although some predictive modelling may be undertaken. Key actions during the Operation work stage to maximise sustainability opportunities, include:

- Reduce further operational and maintenance energy, water and waste through measures such as real-time control optimisation and proactive condition monitoring and maintenance regimes;
- Identify improvements to existing assets through optimisations and refurbishment – noting that in some cases new building/ infrastructure might be required to deliver better performance; and

- Identify alternative consumable projects which have lower sustainability impacts than from existing suppliers.

Responsibility chart

Sustainability activities during operation work stages	Client	Designer	Contractor	Suppliers
Develop a monitoring system that quantifies sustainability performance during operation	RA	C	I	I
Monitor sustainability progress against targets, report progress at life cycle milestones to detect any changes in assets	RA	I	I	I
Engage with the value chain to identify sustainable asset maintenance schedules	RA	R	C	C
For any design and construction works (e.g. maintenance and refurbishment), repeat sustainability management process	RA	C	C	C
Report on sustainable performance to inform the continual improvement process	RA	I	I	I

R: Responsible **A:** Accountable **C:** Consult **I:** Inform

- **End of Life**

The End of Life stage of existing assets should be considered with the same mind-set as if dealing with a new asset.

Key actions during this work stage to maximise carbon reduction opportunities, are to:

- Explore possibilities for extending the asset life and re-using or recycling assets for the same or different uses.
- Assess the possibility of "build nothing solutions" and look to re-use existing assets.
- Assess beneficial asset re-use potential in any assets about to be made redundant – can these be re-used on site and/or can any resources be recovered to use in other assets or markets; and

- Adopt collaborative approaches to identify the best options for re-using/recovering materials and equipment.

The carbon reduction opportunities at the End of Life stage of individual assets should be incorporated into the consideration of new schemes.

Responsibility chart

Sustainability activities during End of life stages	Client	Designer	Contractor	Suppliers
Collect data from assets to be decommissioned to improve future designs on useful material recovery for future assets	A	R	I	I
Explore opportunities for beneficial re-use of materials from existing assets to be decommissioned to be used in new asset design	A	I	R	I
Look for collaboration opportunities across sectors to identify opportunities to re-use assets or demolition material to avoid landfill or other disposal methods	R/A	C	C	C

R: Responsible **A:** Accountable **C:** Consult **I:** Inform

For an organisation to fully utilise knowledge assets management must promote and support the creation, sharing and use of knowledge among employees and discourage knowledge hoarding. Successful organisations have employees who consistently collaborate, cooperate and communicate both formally and informally. The organisation must take the initiative to change their environment to one that is conducive to sharing knowledge.

This is the third and final stage of the proposed framework. The outputs are in the form of competitiveness variables. Sustainability initiatives can enhance competitiveness in several ways. For most organisations, the ultimate focus of sustainability strategies and programmes must be long-term performance. This study results shows that effective implementation of sustainability initiatives have positive impact on improved reputation, improved cost savings, and improved employee satisfaction. Therefore, the current study results clearly suggest that organisations are creating environmental, social and economic values thorough effective implementation of sustainability initiatives.

Output: Sustainable value creation – Greenhouse gas emissions

Greenhouse gas emissions	Performance indicators	Actual results	Targeted results	Deficit
Non-Financial indicator tCo2E 000's	• Total gross emissions for scopes 1,2, &3			
	• Total net emissions for scopes 1,2, &3			
	• Total gross emissions for scopes 1			
	• Total gross emissions for scopes 2 &3			
Related energy consumption KWh 000's	• Electricity: Non-renewable			
	• Electricity: Renewable			
	• Gas			
	• LPG			
	• Other			
Related equipment energy consumption Litre 000's	• Aviation travel fuel			
	• Diesel (retail blend and mineral blend)			
	• Diesel (retail blend)			
	• Diesel (100% mineral)			
	• Gas oil			
	• Petrol			
Financial indicators (AED)	• Expenditure on energy			
	• Expenditure on official business travel			
	• Expenditure on equipment energy (fuel)			
Normalisation	Total scopes 1,2, &3 – tCo2-e 000's			
	• Total department spend			
	• Normalisation – scope 1 &2 emissions '000/ budget '000			

Output: Sustainable value creation – water consumption

Finite resources consumption – water	Performance indicators	Actual results	Targeted results	Deficit
Non-Financial indicator M^3 000's	• Water consumption (office estates)			
	• Water consumption (workshop)			
	• Water consumption (non-office and workshop)			
Financial indicators (AED)	• Water supply costs			
	• Total department spend on water supply			

Output: Sustainable value creation – waste reduction

Waste	Performance indicators		Actual results	Targeted results	Deficit
Non-Financial indicator M^3 000's	• Total waste				
	• Hazardous waste				
	• Non-hazardous waste	• Landfill			
		• Reused/recycled			
		• Composted			
		• Incineration with energy recovery			
		• Incinerated without energy			
Financial indicators (AED)	• Total disposal cost				
	• Department total				

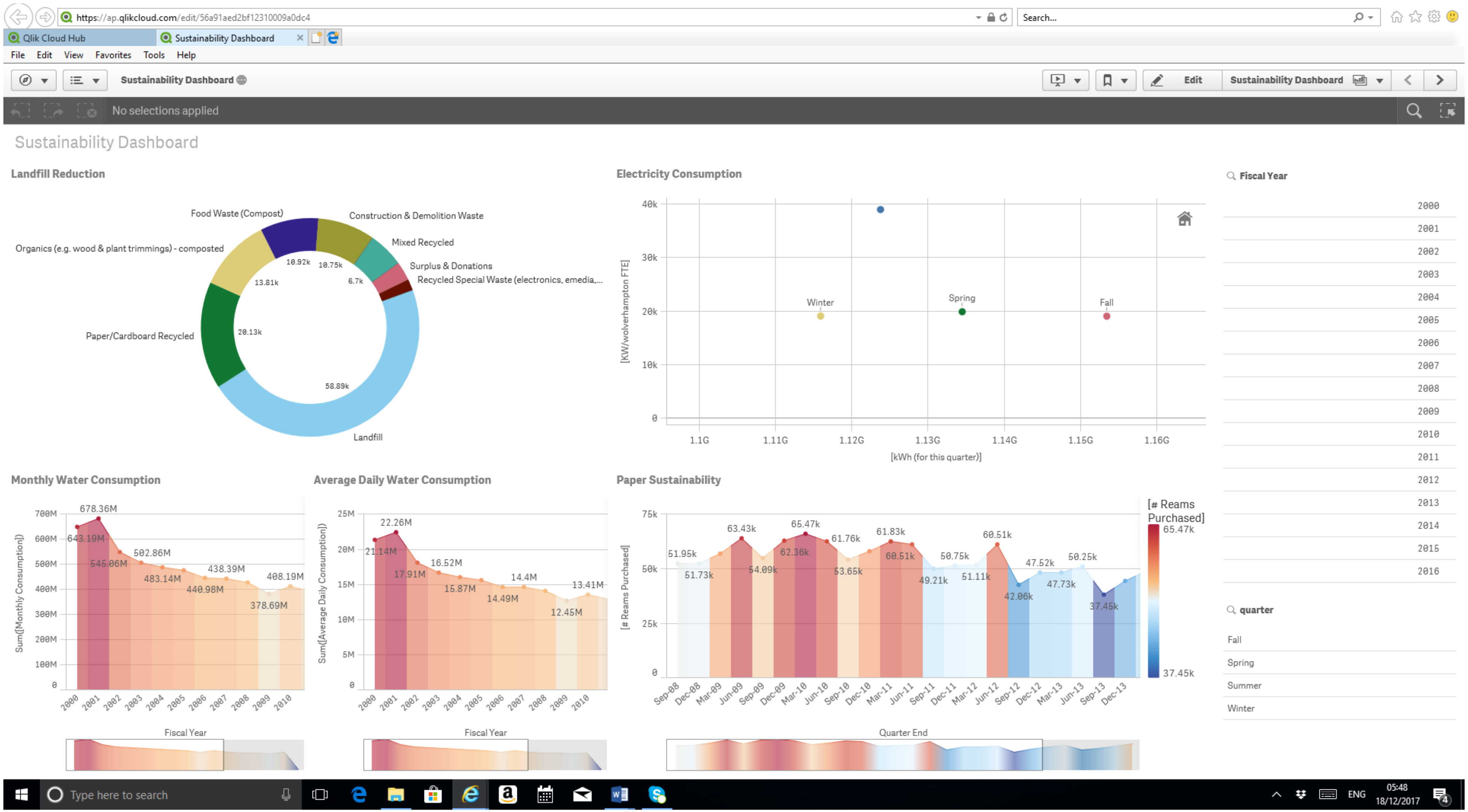
10.4 SUSTAINABILITY DASHBOARD

Building and maintaining trust in businesses and governments is fundamental to achieving a sustainable economy and world. Every day, decisions are made by businesses and governments which have direct impacts on their stakeholders, such as financial institutions, labor organisations, civil society and citizens, and the level of trust they have with them. These decisions are rarely based on financial information alone. They are based on an assessment of risk and opportunity using information on a wide variety of immediate and future issues. As authors such as Roarty (1997) and Rodriguez Melo and Mansouri (2011) have indicated society is becoming increasingly aware of environmental and social issues hence it would be advantageous to utilise sustainable initiatives in order to improve the organisation's reputation. This is made even more prevalent when reputation, brand and knowledge are considered the principle assets of a company (Kay, 2004). Therefore, organisations must report their annual sustainability performance with their key stakeholders.

The value of the sustainability reporting process is that it ensures organisations consider their impacts on these sustainability issues, and enables them to be transparent about the risks and opportunities they face. A sustainability report is the key platform for communicating sustainability performance and impacts – whether positive or negative. Stakeholders also play a crucial role in identifying these risks and opportunities for organisations, particularly those that are non-financial. This increased transparency leads to better decision making, which helps build and maintain trust in businesses and governments. However, as organisations take sustainability reporting seriously, they struggle with a system that would create a clear reporting overview of all sustainability issues and performance.

The currently sustainability-related data and information is delivered by each department annually in individual spreadsheets that have been manually updated and coded. For instance, manually entering the information that is readily available from utility companies, including gas and electricity use, water consumption, fuel consumption, etc. will take more time. Therefore, sustainability-related data management is time consuming and labour intensive. Furthermore, each department is working in isolation and data is not shared across the departments. In addition, both resource usage (e.g., fuel, electricity, water, etc.) and related costs cannot be analysed using the current system. Also, it is difficult to do comparative or strategic analysis of how much of a resource they are using today, but also how much it costs compared to past years. Therefore, there is a need for developing a cloud-based sustainability dashboard application that automatically gathers data from existing data systems shorter intervals (for example, through live meter data where possible, or monthly billing data), or imports data periodically from template spreadsheets, for automated calculation- which is the core raison d'être of this proposed research.

The aim of this developed 'sustainability dashboard' application for presenting greenhouse gas (GHG) emissions, energy and other resource flows, and projections for reduction strategies. The proposed dashboard would improve data integrity, accuracy, and operational efficiency. Also, it would take advantage of visual perception and cognition to present information and statistics in a way that is far easier for people to analyse and understand. It also would enable organisations to identify potential savings and areas where emissions could be reduced (See below figures).



https://ap.qlikcloud.com/edit/56a91aed2bf12310009a0dc4
Qlik Cloud Hub
Sustainability Dashboard
File Edit View Favorites Tools Help
No selections applied
Sustainability Dashboard
Landfill Reduction
Food Waste (Compost)
Construction & Demolition Waste
Mixed Recycled
Surplus & Donations
Recycled Special Waste (electronics, emedia,...
Organics (e.g. wood & plant trimmings) - composted
Paper/Cardboard Recycled
Landfill
Electricity Consumption
Winter
Spring
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[KW/wolverhampton FTE]
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Fiscal Year
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quarter
Fall
Spring
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Paper Sustainability
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Quarter End
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ENG
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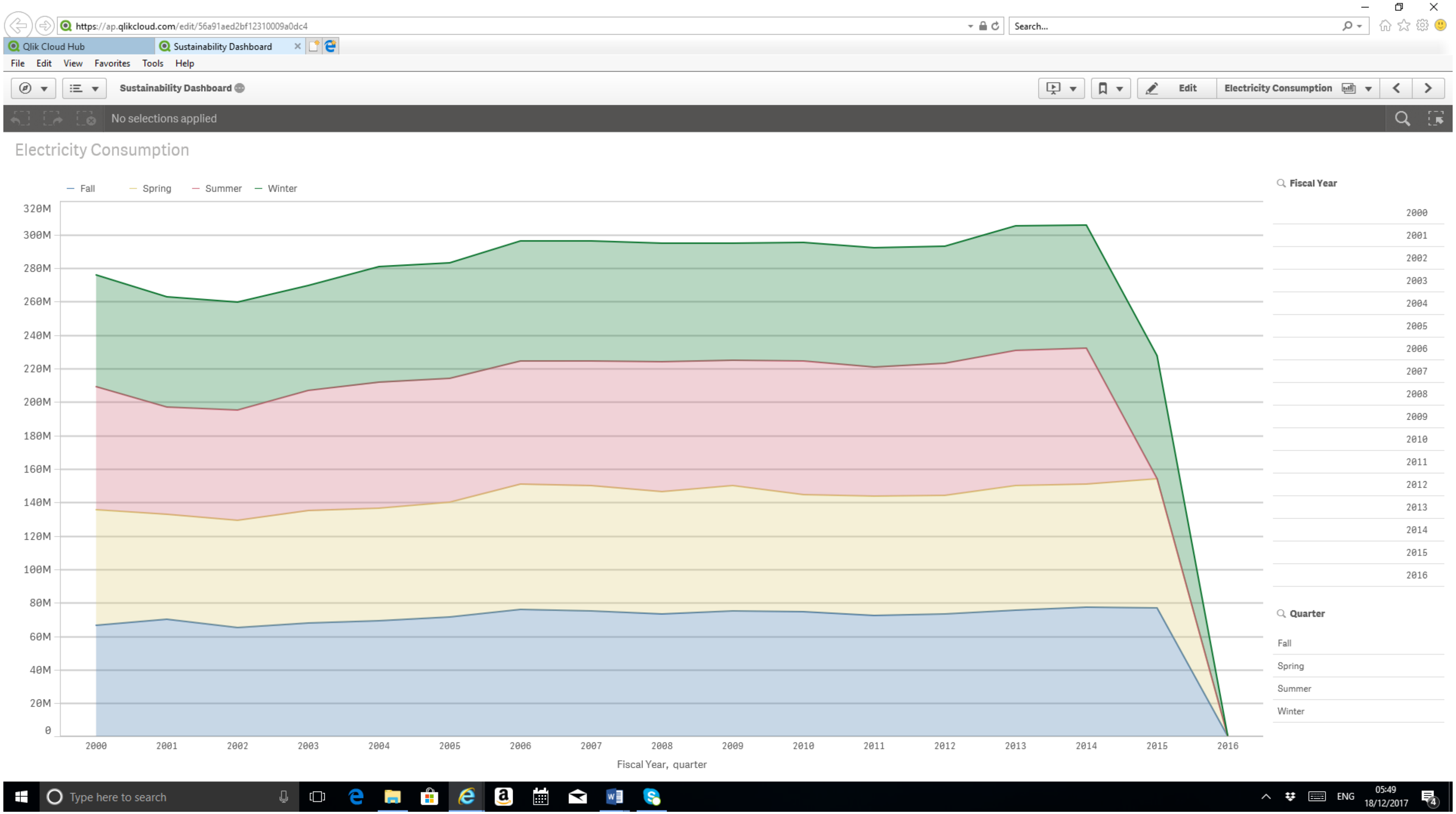
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Qlik Cloud Hub
Sustainability Dashboard
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Sustainability Dashboard
Edit
Electricity Consumption
No selections applied
Electricity Consumption
Fall
Spring
Summer
Winter
320M
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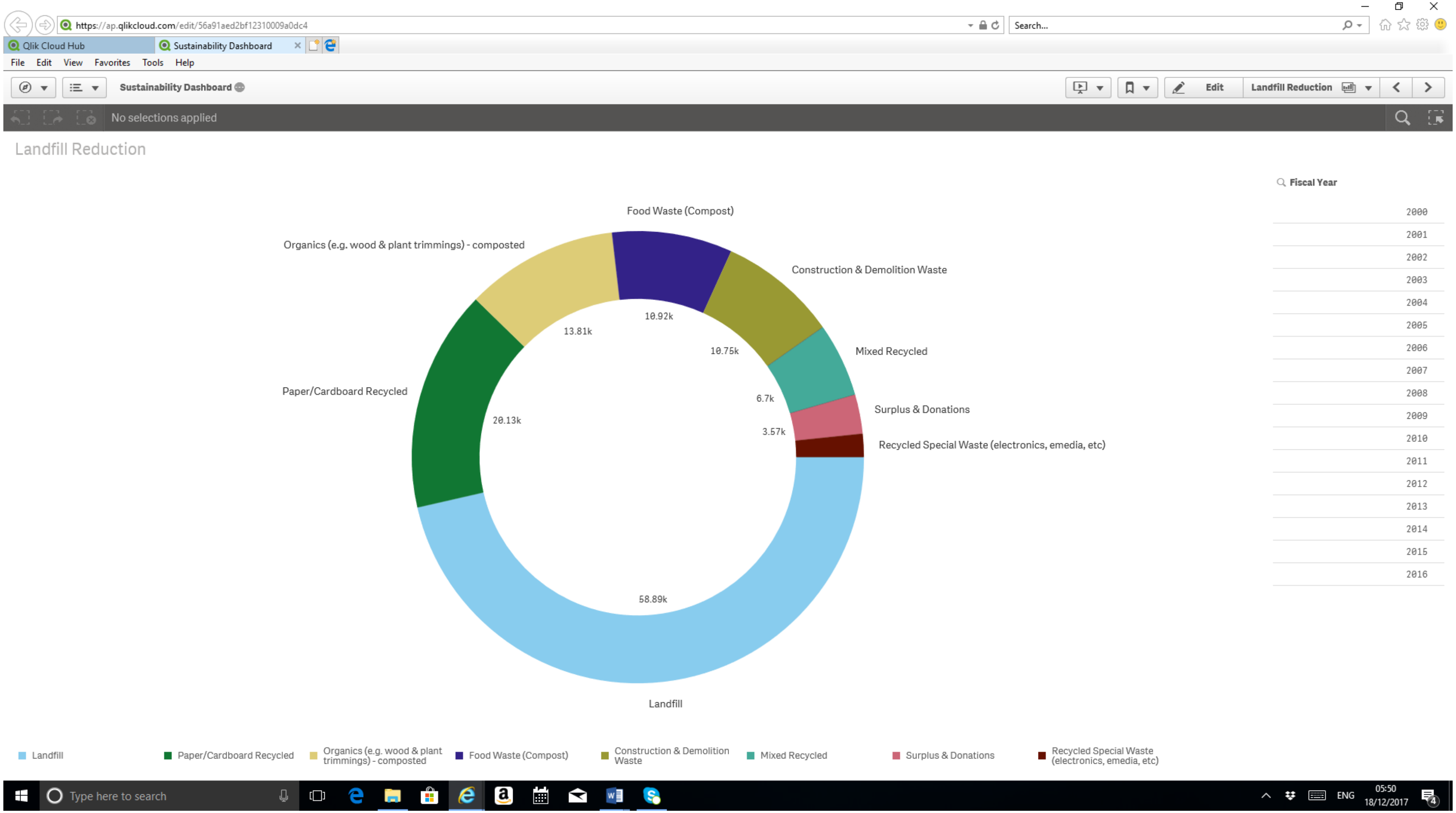
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Landfill Reduction
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Landfill Reduction
Fiscal Year
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2016
Food Waste (Compost)
Organics (e.g. wood & plant trimmings) - composted
Construction & Demolition Waste
Mixed Recycled
Paper/Cardboard Recycled
Surplus & Donations
Recycled Special Waste (electronics, emedia, etc)
Landfill
10.92k
13.81k
10.75k
6.7k
3.57k
20.13k
58.89k
Landfill
Paper/Cardboard Recycled
Organics (e.g. wood & plant trimmings) - composted
Food Waste (Compost)
Construction & Demolition Waste
Mixed Recycled
Surplus & Donations
Recycled Special Waste (electronics, emedia, etc)
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ENG
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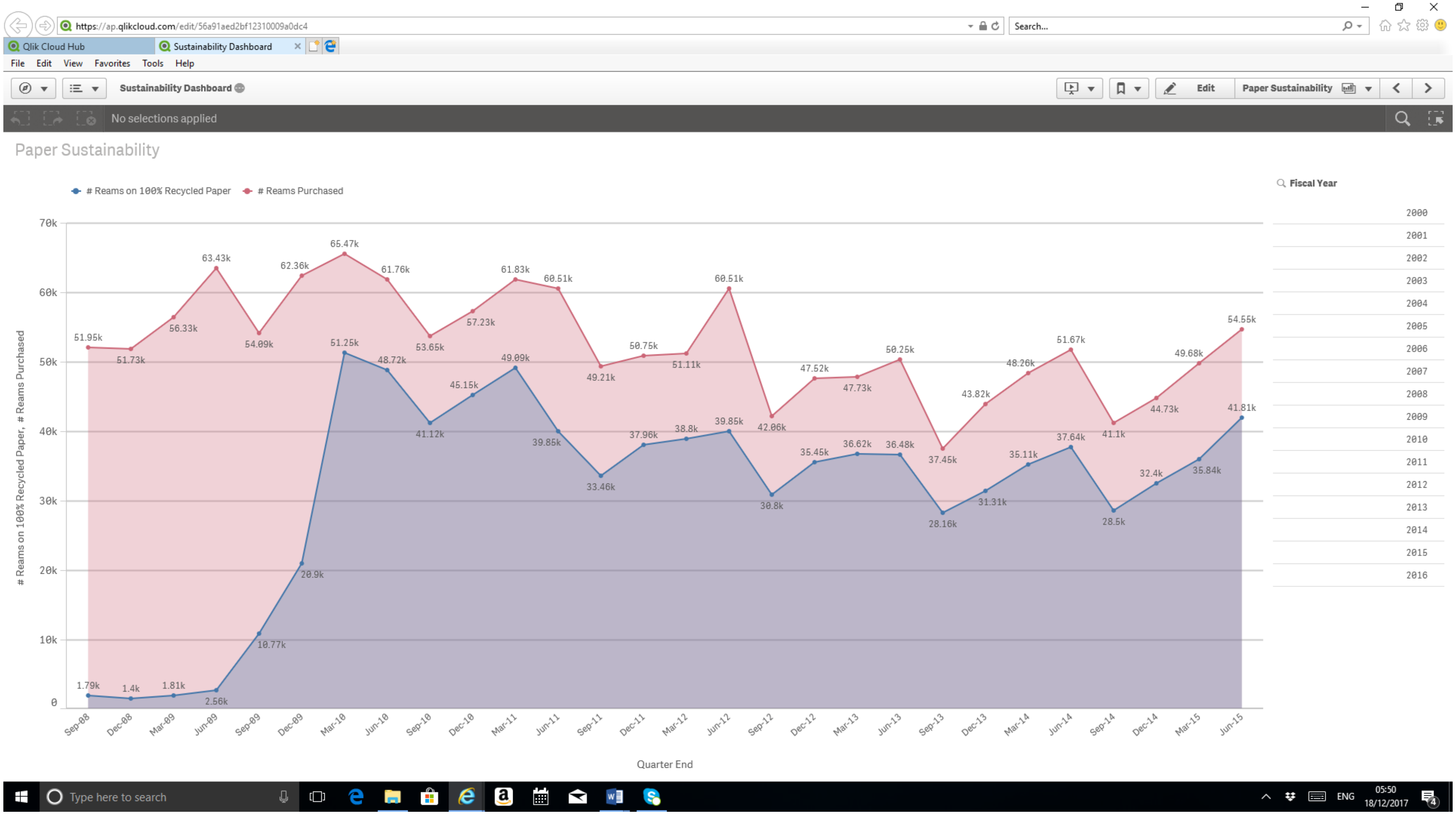
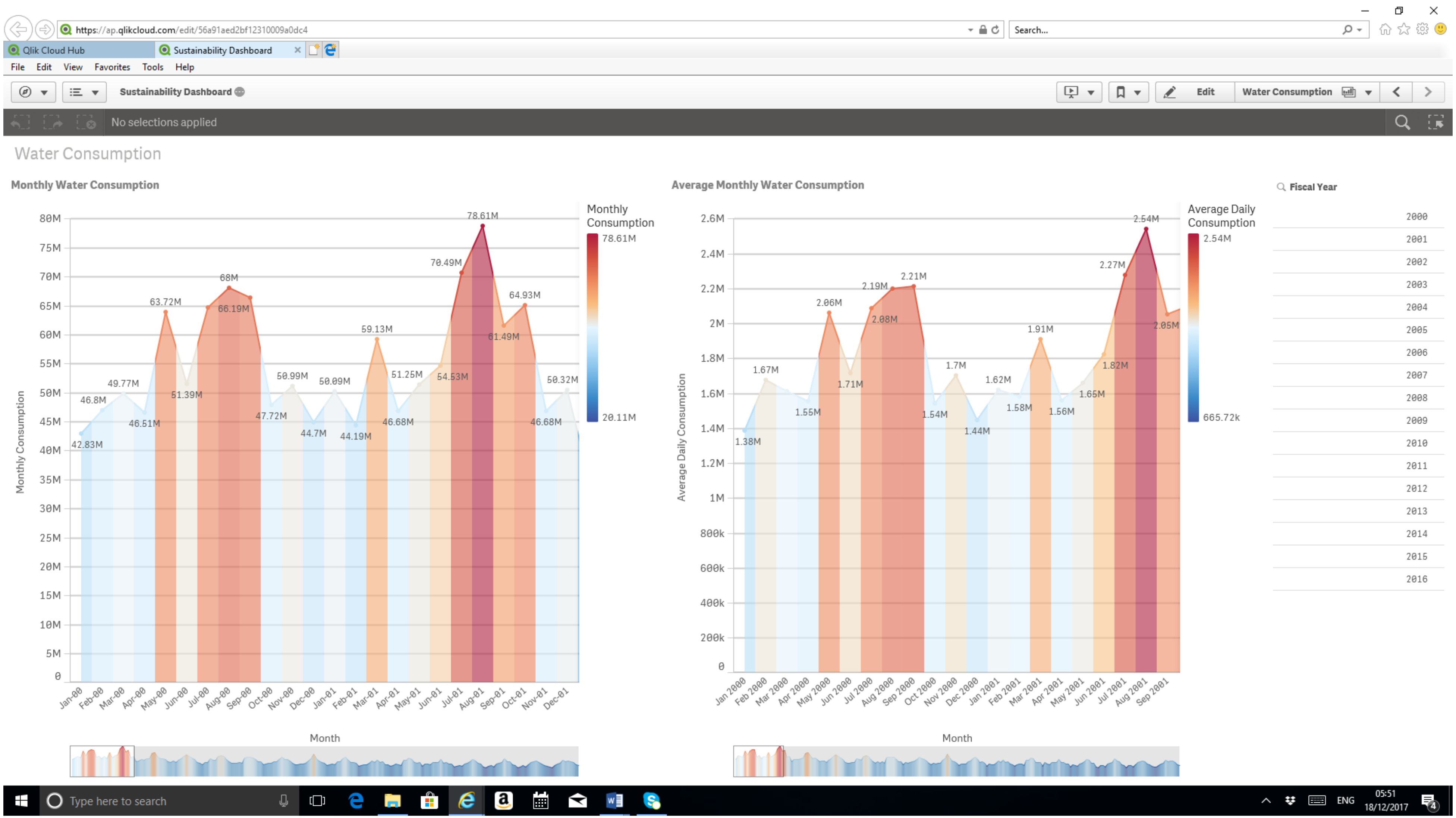
18/12/2017



Paper Sustainability
Reams on 100% Recycled Paper
Reams Purchased
Fiscal Year
Quarter End
Reams on 100% Recycled Paper, # Reams Purchased



https://ap.qlikcloud.com/edit/56a91aed2bf12310009a0dc4
Qlik Cloud Hub
Sustainability Dashboard
File Edit View Favorites Tools Help
Sustainability Dashboard
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Water Consumption
No selections applied
Water Consumption
Monthly Water Consumption
Monthly Consumption
Monthly Consumption
78.61M
20.11M
Month
Average Monthly Water Consumption
Average Daily Consumption
Average Daily Consumption
2.54M
665.72k
Month
Fiscal Year
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The proposed sustainability dashboard application would also help organisations to measure, understand, visualise and communicate their economic, environmental, social and governance performance, and then set goals, and manage change more effectively. Also, it enables the tracking of performance using key performance indicators (KPIs) in a very visual and transparent way. It would also allow organisations to fully understand, and make sense of, the information that was coming out of all their available data. As a result, they could make much more effective and quicker use of their existing information which would help them to establish a clearer vision and strategy for the future sustainability programmes.

10.5 VALIDATION OF THE FRAMEWORK

Validation is defined as an assessment of whether a framework is in congruence with reality (Brink, 2003). The developed framework was validated with 10 senior professionals from the UAE construction organisations. The professionals had over 15 years of work experience in the sustainability strategies implementation. In this study, during face-to-face interview, the interviewees were asked about the comprehensiveness of the developed framework. Most of the interviewees asserted that the framework has a very high degree of comprehensiveness and in terms of areas covered; the developed framework has a very high level sustainability issues. Furthermore, the interviewees were asked if they think the framework would help their organisations to manage sustainability strategies and response from all interviewees was very positive. They considered a framework will help their organisations to identify key drivers, key sustainability initiatives and benefits of implementing sustainability initiatives. Overall, most of the interviewees recommended that the developed framework can be used for implementing sustainability strategies to improve competitiveness. The framework can be further tested and revised in both academic and business context. Overall, framework and its validation attempted to address objective seventh of this research study.

10.6 SUMMARY

This chapter has discussed the development of a framework for managing sustainability strategies in the UAE construction industry. It can aid managers in operationalising a sustainability strategy and tying it to the specific actions that will improve competitiveness. The findings from the previous stages of the research study and aspects from critical review of literature were taken into consideration in the development of the framework. The developed framework consists of 3 stages: inputs, processes and outputs. The developed and validated framework provides broader idea for the integration of sustainability initiatives into day-to-day management decisions. The framework can help managers to systematically think through drivers for implementing sustainability strategies to competitiveness. In doing so, this chapter addressed objective 7 of the current study, which is “to develop and validate a framework for managing sustainability strategies in the UAE construction industry”.

CHAPTER 11 : CONCLUSIONS AND RECOMMENDATIONS

11.1 INTRODUCTION

This chapter discusses the aim, objectives and research questions of the study. In doing so, it presents the finding and also provides conclusions and recommendations. The key findings are discussed with respect to the objectives of the study. Prior to that, the research process is discussed.

11.2 RESEARCH PROCESS

Aim	The aim of this research is to explore how the United Arab Emirates (UAE) construction organisations are embedding sustainable strategies to improve their competitive advantage from a social, environmental and economic point of view.
Research Objectives	• To investigate and document the perception of UAE construction sector on the concept of sustainability • To explore and document the key drivers for implementing sustainability strategies in the UAE construction organisations • To investigate and document the key sustainability strategies needed to effect change that are currently being implemented in the UAE construction organisations • To critically appraise and document the main challenges the UAE construction organisations face in implementing sustainability strategies. • To critically analyse the implementation of green Building Information Modelling (BIM) strategies in achieving the sustainability goals of the UAE construction organisations • To critically analyse the implementation of mobile application technologies to address sustainability issues in the UAE construction industry • To develop and validate a framework for managing sustainability strategies in the UAE construction industry
Research questions	1. What does sustainability mean to UAE construction organisations? 2. What are the key drivers that have fuelled the need for implementing sustainability strategies in the UAE construction organisations? 3. What are the key sustainability strategies currently being implemented in the UAE construction organisations needed to effect change? 4. What key challenges do UAE construction organisations face in implementing sustainability strategies? 5. What are the key green BIM strategies currently being implemented in in achieving the sustainability goals of the UAE construction organisations? 6. How can the implementation of mobile application technologies support UAE construction organisations in the mitigation and control of their current sustainability problems? 7. Is there a need for developing a framework for managing sustainability strategies in the UAE construction industry?
Research	Qualitative research
Sample technique	Purposive sample
Sample size	44
Sample diversity	Directors and managers responsible for sustainability strategies implementation
Data collection method	Semi-structure interviews
Unit of analysis	Construction organisations
Embedded unit of analysis	Individual employee
Method of analysis	Content analysis
Outcome of analysis	Framework

11.3 KEY FINDINGS

Research Objective 1: To investigate and document the perception of UAE construction sector on the concept of sustainability.

Research Question 1: *What does sustainability mean to UAE construction organisations?*

This study revealed that, the concept of sustainability falls broadly into four key dimensions. They are: environmental sustainability dimension, economic sustainability dimension, social sustainability dimension and triple bottom line dimension. From this study, it is apparent that the environmental sustainability dimension predominates compares to economic, social and triple bottom line dimensions of sustainability. It could be noted that, although the importance of sustainability is broadly acknowledged within the UAE construction sector, there is a significant lack of a common and operationalised understanding on the concept of sustainability. In the long-term, construction businesses should be aiming to create more openness in acknowledging and addressing the issues of sustainability. Therefore, sector-wide awareness rising programmes on the concept of sustainability needs to be implemented. The existing education and training programmes need some reorientation.

Research Objective 2: To explore and document the key drivers for implementing sustainability strategies in the UAE construction organisations

Research Question 2: *What are the key drivers that have fuelled the need for implementing sustainability strategies in the UAE construction organisations?*

Five key drivers have fuelled the need for implementing sustainability initiatives in the UAE construction organisations. They are: costs reduction, attracting clients, legislation, management commitment, and to improve reputation. When examining the drivers many of them displayed the expected competitive advantage the companies expected to obtain. Many of the drivers seek to add value into the organisations, the most notable example of this was the driver of attracting clients. Implementing sustainable measures with the goal to attract clients clearly provides a competitive advantage as sustainability is a real world requirement. It is concluded that before organisations embed sustainability initiatives they need to understand and recognise key drivers, which are pushing them towards implementation. Therefore, understanding the drivers for implementing sustainability initiatives is important.

Research Objective 3: To investigate and document the key sustainability strategies needed to effect change that are currently being implemented in the UAE construction organisations

Research Question 3: *What are the key sustainability strategies currently being implemented in the UAE construction organisations needed to effect change?*

This study revealed nine key initiatives under the umbrella of sustainability that have been implemented in the UAE construction organisations. In the order of implementation, they are: waste minimisation strategies, lean construction techniques to promote Health and Safety practices, low carbon strategies, sustainable procurement strategies, equality and diversity strategies, workforce sustainability strategies, smart cities strategies, building information modelling and smart technologies strategies. Overall, the outlook for improved sustainability initiatives efforts from the UAE construction organisations looks quite promising at present. This is because organisations those implement sustainability initiatives will benefit from improved reputation, better employee engagement, lower operating costs, and better relationship with key stakeholders. Clear and strong brand, should improve the public perception of the quality of services that construction firm offers, and this in turn, will increase the trust, loyalty and will help reducing the perceived risk.

Research Objective 4: To critically appraise and document the main challenges the UAE construction organisations face in implementing sustainability strategies.

Research Question 4: *What key challenges do UAE construction organisations face in implementing sustainability strategies?*

The interviewees noted a number of obstacles in the prevention of sustainable development, the constraints went against the aspects of competitive advantage which were high costs of implementing measures and inflexibility countering the holistic viewpoint which sustainability seeks to develop. High costs go against the eco-efficiency outlook attached to sustainable development. High costing seems being prevalent in the data seems to be contrary to the fact cost reduction was the highest emphasised driver for sustainable measures. In order to understand this it is important to remember that legislation also serves as a driver towards the implementation sustainability.

It is crucial to ascertain the flexibility of sustainability in a strategic business outlook, which has been done through determining its relationship alongside competitive advantage. This expands on the understanding of sustainability from primarily a morally responsible course of action towards a credible method of creating value for organisations within the AEC industry. Sustainability is looking to become institutionalised and this study demonstrates the potential towards serving the organisations while serving and benefiting society and the environment.

Research Objective 5: To critically analyse the implementation of green Building Information Modelling (BIM) strategies in achieving the sustainability goals of the UAE construction organisations

Research Question 5: *What are the key green BIM strategies currently being implemented in in achieving the sustainability goals of the UAE construction organisations?*

The present study was evaluated the current state of the implementation of green BIM within the UAE construction sector. Problems encountered since the beginning of the investigation started to point out the lack of maturity of this issue within the construction industry, and the little knowledge that we have about the benefits and multiple applications that have BIM, when it is desired to develop sustainable projects. Encourage the development of more environmentally friendly construction methods with the environment that can be applied in different types of projects, based on green BIM tools. As the buildings are entities requested and used by people, it is imperative that the community is aware of the benefits that entails the implementation of green BIM and sustainable policies, which may be required for its adoption. Therefore, the diffusion of the green BIM methodology and sustainable construction, through programs, and communication and advertising campaigns, help governments to fulfil their objectives and contribute to the strengthening of the UAE construction industry.

Each country plays an important role regarding the implementation of BIM and sustainable projects development. The creation of standards and targets to be followed by building professionals, have served as a guide to achieve the objectives in every project. Sustainable construction is of international concern. Awareness about the importance of sustainable construction has increased, which will increase the number of buildings and projects developed in this way. Regarding green BIM, remember that is in a process of transition, and should be taken with patience.

The countries leading the implementation of BIM worldwide, such as the United States and the UK, have set targets that drive their application in the construction industry, however there is still the need to disseminate knowledge about what is green Building Information Modelling and benefits involved in their use in an infrastructure project. Not worth developing excellent programs and regulations, if there are no trained professionals in the area. Green BIM is a process that involves all stakeholders of a project, from the contractors to the client. If any of them are not trained to follow the desired flow, the project will not have the success and the expected results. It would therefore be beneficial to the UAE government provide financial and economic support for the education of the different professionals in the construction sector.

Research Objective 6: To critically analyse the implementation of mobile application technologies to address sustainability issues in the UAE construction organisations

Research Question 6: *How can the implementation of mobile application technologies support UAE construction organisations in the mitigation and control of their current sustainability problems?*

Mobile Applications can offer a variety of benefits and capabilities to the management of construction Environmental, Health, and Safety issues. However, the effective arrangement of these capabilities is what defines whether an application is effective or not. It was observed that the main benefits obtained by using Applications include an enhanced reporting of sustainability metrics that enforce decision making, reduced energy consumption, and more efficient waste management.

The study revealed that the uptake of mobile applications in the UAE construction industry is still in developing stage. Most often cited reasons for using mobile applications in their organisations include: to manage Environmental Health & Safety (EHS); to management energy; to manage site waste; to manage water; to reduce capital costs; to reduce completion time; to improve predictability; to improve productivity; to improve revenue; to enhance demand forecasting; to enhance inventory management; and to enhance site logistic planning. Some of the areas construction organisations that are being currently tackled by these technologies are energy management, carbon emissions management and construction health and safety management. Some of the areas the UAE construction organisations that are being currently tackled by these technologies are energy management, carbon emissions management and construction health and safety management.

As it was seen, sustainability issues are dynamic and depend on many variables that can change over time. As a result, the continuous control and supervision are necessary in order to assure an effective management of the problems related to sustainability. As a solution to this, the construction industry has found mobile technology to be an approach to obtain and process information. The UAE construction sector is trying to modernise the form in which projects are being undertaken and is looking at sustainable mobile applications as a portable and feasible solution for better communication, integration and collaboration tool.

Objective 6: To develop and validate a framework for managing sustainability strategies in the UAE construction industry

A strategic framework for managing sustainability strategies in the UAE construction industry was developed and validated. It can aid managers in operationalising a sustainability strategy and tying it to the specific actions that will improve environmental, social and economic value. The developed framework provides broad guidance for the integration of sustainability initiatives into day-to-day operational decisions. The findings from the previous stages of the research study were taken into consideration in the development of the framework. The developed framework consists of 3 stages: inputs, processes and outputs. The framework can be further tested and revised in both organisation and academic environment.

11.4 RECOMMENDATIONS

Recommendations for decision makers

- The construction industry is currently in a new era, industry 4.0 has been introduced which relates to utilising technologies in the construction industry to improve quality, save time and cost and improve construction practices. There are many technologies which are involved with Industry 4.0, and few companies in the UAE have already adopted some of the technologies. These technologies include virtual reality, augmented reality, BIM, just to name a few. Based on the findings from the research, most projects have adopted a variety of technology, mainly BIM as it has been mandated in the UAE. Other technologies such as Virtual Reality is being used for benefits such as allowing companies to demonstrate the future final product to the public and improve decision making within the project teams.
- Most of the technologies included in Industry 4.0 are still at their infancies and for the future would recommend more research to be carried out on these technologies, this will enable the construction industry to understand the benefits

that can be gained from these technologies and with the industry being known for resisting change, demonstrating these benefits can be the start of the construction industry embracing the change.

- It is concluded that sustainability issues are complex, dynamic, and multifaceted. Most of the sustainability initiatives are inherently collaborative, as they relate to supporting the community and future generations. Therefore, to solve some of the global sustainability problems, it is important that key leaders and decision makers connect with other stakeholders to have a positive social impact.
- In current business environment, traditional product innovation is not enough to ensure an organisation sustainable competitive advantage. To achieve that, organizations must value new methods of value creation. Business model innovation allows the delivery of novel value proposition to consumers by the transformation of the value creation, delivery and capture mechanisms. However, there are scenarios where business model innovation fails mainly when organisations fail to meet the defined goals for the process and to align functional parts of the organisation to deliver the desired outcome.
- The countries leading the implementation of BIM worldwide, such as the United States and the UK, have set targets that drive their application in the construction industry, however there is still the need to disseminate knowledge about what is green Building Information Modelling and benefits involved in their use in an infrastructure project. Not worth developing excellent programs and regulations, if there are no trained professionals in the area. Green BIM is a process that involves all stakeholders of a project, from the contractors to the client. If any of them are not trained to follow the desired flow, the project will not have the success and the expected results. It would therefore be beneficial to the UAE

government provide financial and economic support for the education of the different professionals in the construction sector.

- The benefits obtained from the implementation of sustainable mobile applications prove to be an assurance to the mitigation of organisations' sustainability problems. Furthermore, it can be assumed that these benefits can be extended to other UAE construction organisations that are willing to implement this technology. And in order to attain this, it is necessary that more regulations and incentives from the UAE government are implemented in the country that can guarantee the increase of the organisations' encouragement with sustainability approaches.
- Smart technology has enormous potential to enable construction organisations systems and processes to be automated; to provide managers with better data/information; and to support them in performing more tasks and activities while remaining visible to their communities. Therefore, there is a need for implementing more smart technology initiatives in the UAE construction sector. It is recommend that implementing regulations to push large organisations to implement smart devices in their projects, and to subsidise this implementation in small and micro companies.
- In order to keep the environment safe and pollution free, the government generally introduces number of environment regulations that imposes certain restrictions on the project. This further affects the project functioning eventually affecting the project performance. The lack of leadership skills for successful deployment of environment sustainability initiatives is one of the most important challenges for the UAE construction sector. Therefore, there is an urgent need to develop and deliver a bespoke leadership training programs to address, improve

and measure the effectiveness of leadership skills for driving change towards sustainability.

Recommendations for the UAE construction sector

- Overall, the outlook for improved sustainability initiatives efforts from the UAE construction organisations looks quite promising at present. This is because organisations those implement sustainability initiatives will benefit from improved reputation, better employee engagement, lower operating costs, and better relationship with key stakeholders. Clear and strong brand, should improve the public perception of the quality of services that construction firm offers, and this in turn, will increase the trust, loyalty and will help reducing the perceived risk.
- Associated economic, social and environmental impacts population growth and the resulting pressure on the limited resource the planet can offer have encouraged the UAE organisations to find new and more sustainable ways to operate. As a consequence organisations are required to ensure that their operations create positive impact on the environment and society. Furthermore, organisations are increasingly recognizing opportunities for profitability from the adoption of business models that address sustainability challenges.
- The implementation of smart technologies initiatives to deal with sustainability initiatives is still evolving in the UAE construction organisations. Taken together, the impact of leadership, sustainability-related policies, structures, reward systems, training programmes and performance reporting are key factors in successful implementation of sustainability initiatives. It is suggests that more clarity is needed on how the UAE construction organisations must change to meet the sustainability challenge, and how the necessary changes may be

achieved. Therefore, there is a need for cross-sector collaboration to capture and share best and worst practices related to implementing smart technologies.

- The UAE construction organisations that have implemented sustainable mobile applications have experienced positive benefits include a precise, clear and reliable reporting system with potential scalability, an enhanced timely tactical decision-making, a more efficient management of hazardous materials and waste, a well-organised management of KPIs, and an overall improved control of electricity, water, fossil fuel, waste, transport and supply chain. However, selecting the appropriate application that can meet the organisation's requirements is imperative. In addressing the adequate application, organisations must consider the different factors that were presented in the software selection framework. This can ensure the right selection of the software that provides more benefits to the organisations strategies towards sustainability.
- Encourage the development of more environmentally friendly construction methods with the environment that can be applied in different types of projects, based on green BIM tools. As the buildings are entities requested and used by people, it is imperative that the community is aware of the benefits that entails the implementation of green BIM and sustainable policies, which may be required for its adoption. Therefore, the diffusion of the green BIM methodology and sustainable construction, through programs, and communication and advertising campaigns, help governments to fulfil their objectives and contribute to the strengthening of the UAE construction industry.
- The construction industry is at an evolutionary period, the new generation of the construction industry - Industry 4.0 is expected to boost quality, improve productivity and efficiency. The industrial production is being transformed by technologies, and these digital technologies are being currently used in

manufacturing and if fully adopted by the UAE construction sector can lead to better efficiency and enhance relationships between all disciplines in an organisation.

Recommendations for academics and researchers

- The scarcity of knowledge and expertise associated with sustainability initiatives is, and will continue to be, a huge challenge for the UAE construction organisations. Therefore, training programmes related to the management of sustainability-related knowledge will help leaders, managers, and change agents to better understand on how to craft and implement various sustainability-related strategies for competitive advantage.
- The study concludes that adoption of digital technologies in the UAE construction industry are still at their infancy's, technologies such as BIM and Mobile Applications are mostly common now and are being used widely in the western countries. Other technologies such as VR, Drones and Robotics are still at their prime stages, drones and VR are trailed on some projects in the UAE however they are not very much used yet. Therefore, the UAE business and construction education curricula must integrate the digital technology aspects into its courses.
- By innovating their business models organisations have become better capable of creating positive social and environmental change by redefining the purpose of the organisation, developing mutually beneficial relationship with stakeholders or by increasingly interacting with the market as they seek for legitimacy throughout institutions and market they operate. Ideally a sustainable business model is one that contributes to sustainable development while

ensuring competitive advantage by delivering greater forms of value to customers.

11.5 FUTURE WORK

This research study has revealed a number of areas for further research and development including the following areas:

- It would be worthwhile to explore the differences between micro enterprises (organisation employee size less than 10), small and medium-sized enterprises' (organisation employee size less than 250) and large organisations (organisation employee size more than 250) approach to managing sustainability strategies in the UAE construction organisations.
- Given that the research reported in this thesis is largely exploratory in nature, the results presented here are only tentative and of limited value for the purpose of generalisation. Therefore, additional research with more elaborate and better articulated designs is therefore called for, to further explore the complex issue of managing sustainability issues.
- The developed framework can be implemented in the UAE construction organisations. It is suggested that an action research could be conducted to test the impact of the framework.

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APPENDIX A: PROTOCOL FOR SEMI-STRUCTURED INTERVIEWS

SUSTAINABLE AND DIGITAL STRATEGIES FOR ENHANCING UNITED ARAB EMIRATES CONSTRUCTION INDUSTRY COMPETITIVENESS

SEMI-STRUCTURED INTERVIEW QUESTIONS

Date	
Time of interview	
Organisation	

	Name of Interviewee	…………………………………………………………
	Position of Interviewee	…………………………………………………………
	Organisation total employee size	…………………………………………………………
	Please kindly tell me a little about what your current job role is in the organisation?	
	• Given your role in this organisation, please explain what does "sustainability" mean to you and your organisation?	
	• Can you describe the key drivers that have fuelled the need for implementing sustainability strategies in your organisation?	
The next few questions will focus on key sustainability strategies that have been implemented in your organisation.		
	From the job role and responsibilities that you perform in this organisation, please, describe key 'sustainability strategies that are currently being implemented in your organisation	
The discussions have been very interesting. The next few questions will focus on main challenges organisations face in implementing key sustainability strategies.		
	• From the job role and responsibilities that you perform in this organisation, please, enlighten me on the main challenges your organisation face in implementing sustainability strategies?	
The next few questions will focus on the impact of key sustainability strategies on organisational competitiveness.		
	• From the job role and responsibilities that you perform in this organisation, please, enlighten me on the key green BIM strategies currently being implemented in your organisation in achieving the sustainability goals? • Given your job roles and responsibility, kindly explain how can the implementation of mobile application technologies support your organisation in the mitigation and control of current sustainability problems? • In your view is there a need for developing "is there a need for developing a framework for managing sustainability strategies?	

Thank you for your views on the above questions. I would also like to thank you for the time you have dedicated to this research. If you are interested to know the outcome of this research, it would be my pleasure to share it with you.

Consent form

SUSTAINABLE AND DIGITAL STRATEGIES FOR ENHANCING UNITED ARAB EMIRATES CONSTRUCTION INDUSTRY COMPETITIVENESS

Consent Statement

- I agree to participate in the above research project and give my consent freely.
- I understand that the project will be conducted as described in the "Information Sheet", a copy of which I have retained.
- I understand that I can withdraw from the project at any time and do not have to give a reason for withdrawing.
- I consent to participate in an interview with the researcher.
- I understand that my personal information will remain confidential to the researcher.
- I understand that my organisation will not be identified either directly or indirectly.
- I have had the opportunity to have questions answered to my satisfaction.

Print Name: ___________________________________

Signature: _____________________________ Date: ___________________

Contact Address:
____

____

Phone Number: ________________________

Fax Number: ______________________________

Email Address: ______________________________

Dear Sir/Madam

Re: A FRAMEWORK FOR IMPLEMENTING SUSTAINABLE AND DIGITAL STRATEGIES IN THE UAE CONSTRUCTION INDUSTRY

I am a PhD student at the University of Wolverhampton, U.K. and currently conducting an interview to validate a research framework titled as above. The overall aim of this research is to investigate how UAE construction organisations are embedding sustainable and digital strategies so as to improve their competitiveness. The results of the study will benefit UAE construction industry through improved awareness and understanding of (a) the key challenges facing organisations implementing sustainability initiatives across the value chain (b) the impact of sustainability initiatives on organisational competitiveness and (c) it provides broader guidance for organisations to implement sustainability initiatives into day-to-day practices across the value chain.

This discussion aims to gather your responses which will help the researcher to validate a framework that will subsequently be applied for the effective implementation of sustainability strategies in the UAE construction organisations. This cannot be effectively developed without your participation; therefore, you are requested to participate in this research discussion. This discussion is estimated to take about 30 minutes.

In order to protect your confidentiality, privacy, dignity and anonymity, your answers will be attached with a unique code that will only be understood and accessed by the researcher. This will be stored in a password-protected computer that only the researcher has access to. Finally, any data provided by you will be destroyed once the degree is achieved. The project has ethical approval for the study protocol from the University of Wolverhampton, which provides further assurance.

If you have further questions about your participation, please contact me or my supervisor using the details below.

Thank you in advance for your help in conducting this research and I am looking forward to seeing you at the validation interview.

With best regards

Ahmed Alneyadi
University of Wolverhampton
Wulfruna Street, Wolverhampton.
England, WV1 1LY

APPENDIX B: DETAILS OF ORGANISATIONS THAT PARTICIPATED IN THE SEMI-STRUCTURED INTERVIEWS

A break-down of professionals who were interviewed for the study

Responsibility of interviewee in the organisation	No. of Interviews
Directors	
• Sustainability directors	4
• Director for sustainability	2
• Director for project delivery	2
• Procurement director	5
• Construction director	5
• Technology director	2
Advisors	
• Sustainability advisor	4
• Estidama advisor	2
• Environment, Quality, Health, Safety and advisor	6
Managers	
• Senior sustainability manager	3
• Construction manager	3
• Site manager	3
• BIM manager	3
Total	**44**

APPENDIX C: VALIDATION

VALIDATION OF A FRAMEWORK FOR IMPLEMENTING SUSTAINABLE AND DIGITAL STRATEGIES IN THE UAE CONSTRUCTION INDUSTRY

Name: ....…………………………………………………….………

Professional Background:…………………………………………………………

Position / Area of expertise: …………………………………………….…………..

Organisation: ……………………………………………………….……………….

Evaluation of the proposed framework:

1. What is your opinion on the level of coverage (level of completeness) in terms of the overall contents of the proposed strategic framework?
2. What is your opinion on the level of coverage (level of completeness) in terms of the logic (i.e. flow/ sequence within the framework and how it mirrors what should be done) used within the proposed framework?
3. What is your opinion on the issues covered under ‘drivers for implementing sustainability’ under section of the proposed framework?
4. What is your opinion on the issues covered under ‘sustainability issues’ section of the proposed strategic framework?
5. What is your opinion on the issues covered under ‘work stages of the asset delivery’ section of the proposed strategic framework?
6. What is your opinion on the issues covered under ‘sustainability management process’ section of the proposed strategic framework?
7. What is your opinion on the issues covered under ‘knowledge management’ section of the proposed strategic framework?
8. What is your opinion on the issues covered under ‘sustainability dashboard’ section of the proposed strategic framework?
9. What is your opinion on the level of understanding of the proposed framework?
10. Do you have further comments/suggestions regarding any areas that need to be improved/included/deleted within the proposed framework?
11. Would you recommend the strategic framework for use by construction organisations in the UAE?
12. In your opinion what are the practical difficulties or challenges in the implementation of the strategic framework?
13. Are there any other further comments/ suggestions?